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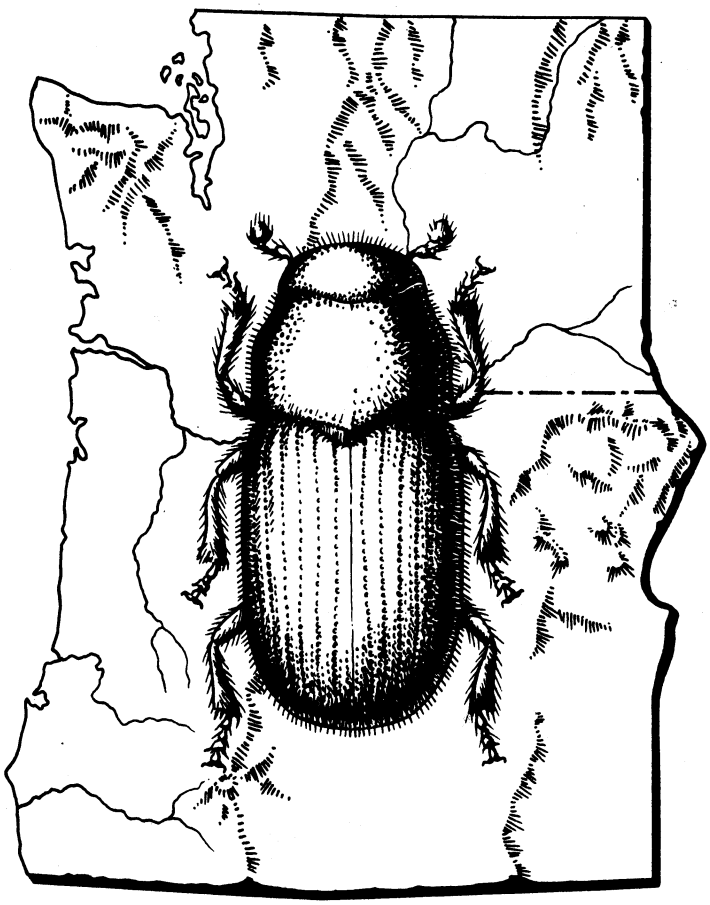
UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE

FOREST INSECT CONDITIONS IN OREGON AND WASHINGTON

1933 – 1938



PREPARED BY
DIVISION OF FOREST INSECT INVESTIGATIONS

FOREST INSECT LABORATORY
445 U.S. COURT HOUSE
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FOREWORD

The control of various injurious insects which attack forest trees and their products is one of the major problems of forest protection and management. In the Pacific Northwest (which in this report refers to Oregon and Washington only), increased attention has been given to this problem during recent years. Insect surveys have been conducted by various timber protective agencies and by the Forest Insect Laboratory of the Bureau of Entomology and Plant Quarantine. Investigations of life habits and methods of control for various forest insect pests have been made by this laboratory, and in many ways information has been accumulated which tells the story of recent forest insect activity, what has been done in the way of control, and what hope there may be for improved methods in the future.

In order to make the highlights of this information available to those interested in checking forest depletion and in following the progress of forest insect control effort, this summarized report has been prepared. Its primary purpose is that of a reference report, bringing together the more important statistical data which are not otherwise available in any one form. The last previous report of similar character was issued on May 1, 1934.(16)* While the original intention was to put out such a report annually, lack of time and personnel has made this impossible. Therefore, the present report summarizes conditions during the last six years, or for the period 1933 to 1938, inclusive.

* Numbers in parentheses refer to reports, memoranda, and publications listed in the appendix.

SOURCES OF INFORMATION

The information on forest insect conditions upon which this report is based has been obtained from three principal sources: (1) Field studies, surveys, and collections made by the personnel of the Forest Insect Laboratory of the Bureau of Entomology and Plant Quarantine; (2) annual bark beetle surveys in the ponderosa pine region conducted with the Forest Service and Office of Indian Affairs; and (3) insect specimens and work samples sent in for identification by the general public.

In the Douglas fir region, no systematic surveys have been conducted, and the information on insect activity has been obtained largely by the personnel of the laboratory in connection with field studies in this region.

Insect conditions in the lodgepole and western white pine stands of the Cascade Mountain region have been of primary concern to the National Park Service. Annual insect surveys, inspections, and reports of insect conditions on the forests of national parks and monuments have been required by the National Park Service of their ranger force. Additional observations in the parks have frequently been made by members of the Forest Insect Laboratory.

This information and review will be presented in four parts: Part I--What forest insects are important in the Pacific Northwest; Part II--What has been the insect damage to forests of the Pacific Northwest, 1933-1938; Part III--What is being done to control forest insect damage in the Pacific Northwest; and Part IV--Appendix, containing statistical data and a reference list of reports, memoranda, and publications of this laboratory.

PART I

WHAT FOREST INSECTS ARE IMPORTANT IN THE PACIFIC NORTHWEST

While there are a vast number of insects which prey upon forest trees or work in wood products, comparatively few of these do damage of economic importance. The more destructive forest insects fall into three main classes, i.e., the bark beetles, the defoliators, and the wood borers. A more complete account of various insects which damage forest trees and forest products may be found in a bulletin published in 1938.(10)

Several species of bark beetles attack living trees, and by mining between bark and wood kill the trees outright. This group is consistently the most damaging to forests of this region and includes such well-known species as the western pine beetle, the mountain pine beetle, and the Douglas fir beetle.

Defoliators feed upon the foliage of living trees and some species do such heavy feeding that the trees are unable to recover. Conifers are especially susceptible to this type of damage. When defoliator outbreaks occur, a large quantity of timber may be killed within a period of three to five years. Fortunately, outbreaks of tree-killing defoliators, such as the hemlock looper, the pine butterfly, the Douglas fir tussock moth, and the spruce budworm, occur only at infrequent intervals.

Wood borers do their greatest damage to wood products and are seldom important as tree killers. In this class may be grouped the termites, carpenter ants, ambrosia beetles, flatheaded and roundheaded borers, and powder-post beetles.

In the Pacific Northwest, fortunately, there are only a few of these insects which repeatedly cause damage of economic importance. The present discussion will be limited to these few, which either kill trees outright, cause serious injury through defoliation, or do appreciable damage to forest products. In recent years economic damage has been caused principally by seven species of forest tree insects, two shade tree pests, and about six species which damage wood products.

The last six years, 1933-1938, have witnessed a gradual decrease in destructive forest insect activity, over that prevailing in the previous decade. Bark beetles in particular have been less destructive and defoliators have only been moderately active. Just what factors have contributed to bring about this condition it is hard to say. In the case of the bark beetles, extremely low winter temperatures and improved moisture and tree growth conditions have undoubtedly had an influence in checking recent outbreaks. Natural control by parasites, predators, and disease probably accounts for less defoliator troubles. Damage from forest products insects continues from year to year without marked variation. How the various important forest tree, shade tree, and forest products insects have fared during this period is described in more detail in the following paragraphs.

THE PRINCIPAL FOREST TREE INSECTS

Bark Beetles.

Western Pine Beetle (Dendroctonus brevicomis Lec.) This pine beetle continues to be the most destructive tree-killing forest insect in the Pacific Northwest, and since this region has America's greatest remaining storehouse of virgin ponderosa pine, the total volume of timber destroyed ranks this beetle as "forest enemy number one".

Following the severe set-back which the western pine beetle suffered as a result of the cold winter of 1932-33, which was discussed in the last report,(16) the broods succeeded in building back to epidemic proportions during 1933 and 1934, at least in the southern portions of the region. Then with improved moisture conditions in the pine region and gradually improving tree health and resistance, coupled with other severe winters, damage declined until in 1937 a low point of infestation was reached which had not been equaled during the past 18 years of detailed records.

Conditions throughout the ponderosa pine region and infestation trends as shown by the regional bark beetle survey are discussed in detail on pages 11 to 25.

Mountain Pine Beetle (Dendroctonus monticolae Hopk.) Mountain pine beetle epidemics which were so active in Crater Lake and Mount Rainier National Parks up to 1932 were brought under control at that time. Since then, infestation in both parks has remained in a quiescent condition. In recent years, only a few scattered groups of infested trees have been seen in any of the lodgepole or western white pine stands examined along the Cascade Range, although some infestations may exist in unfrequented areas.

In young stands of dense, even-aged ponderosa pine in second-growth forests, considerable activity of mountain pine beetle has been noted. In virgin ponderosa pine stands, as western pine beetle activity declines, the mountain pine beetle becomes more noticeable as an element of endemic infestations.

Douglas Fir Beetle (Dendroctonus pseudotsugae Hopk.) Apparently, outbreaks of the Douglas fir beetle depend upon some contributing cause which provokes activity. The Tillamook burn of 1933 created a major disturbance which was followed by an epidemic outbreak of this beetle. Fire-killed trees were heavily attacked by the beetles in 1934. When their progeny emerged in the spring of 1935, the burned trees were no longer in suitable condition for attack, and so the beetles moved out into green timber within and surrounding the burn. As a result, severe group killing occurred. The progeny from these groups apparently found it difficult to maintain attacks in green timber, and the epidemic subsided with only a light attack of trees in 1936. Many trees near the old groups continued to die, however, during 1936 and 1937, as a result of blue stain developing from

unsuccessful beetle attacks. There has also been, and continues to be, considerable beetle killing of weakened trees around the edges of the burn. In one area comprising about 25 sections, a cruise was made in 1937 and the beetle-caused loss estimated at about 85,000,000 board feet. On the basis of this cruise it is estimated that about 200,000,000 board feet of Douglas fir in the vicinity of the Tillamook burn were killed by beetles within three years after the fire occurred.

For several years the Douglas fir beetle has been fairly active on the Chelan National Forest and the adjacent Sinlahekin Game Preserve. In 1933 very heavy losses were reported on both areas, and moderately heavy losses have been sustained during the past four years. In 1935 the infestation appeared to be fairly aggressive, with group killings noted on even the good sites. The infestation on the Sinlahekin Game Preserve had completely subsided by the fall of 1936. However, this insect is still noticeably active on poorer sites and around forest camp grounds.

Another outbreak of this bark beetle was reported by the National Park Service, on the Oregon Caves National Monument, in the summer of 1934.(90, 91) Examination of the area showed about 480 acres affected and trees dying in groups of 8 to 10. It appeared that the primary damage had occurred in previous years, and the current loss was due to subsequent dying from blue stain following up old beetle attacks.

In 1936 a light selective cutting was combined with a salvage logging operation in mature Douglas fir near Cushman Lake on the Olympic National Forest, where a blow-down had occurred in the winter of 1934-1935. The Douglas fir beetle developed a brood in the windthrown trees, emerged, and attacked some of the reserve stand before logging was begun. Consequently, it was necessary to reenter the area in 1937 and again in 1938 in order to salvage many of the reserve trees that were killed by the Douglas fir beetle.

Other Bark Beetles, Weevils, and Cambium Miners.

Other bark and cambium mining insects which caused noticeable damage during 1934 to 1938 were as follows:

In the ponderosa pine region, Ips beetles caused widespread damage to reproduction and pole stands during the summer of 1934. This unusual activity may have been due in part to the extensive road slashings, thinnings, and other cuttings incident to the starting of the CCC program.

In the Douglas fir region, the Douglas fir hylesinus (Pseudohylesinus nebulosus Lec.) was reported in March 1935 in the vicinity of Snider Ranger Station on the Olympic National Forest of Washington as "killing quite a lot of Douglas fir second growth 30 to 50 years of age".

At several points in Washington, the Douglas fir tip weevil (Cylindrocopturus longulus Lec.) was found in 1935 and subsequent seasons doing extensive tip killing of small Douglas firs on poor sites. As a consequence of drought conditions in the fall of 1936, this insect was abundant during the summer of 1937 on Douglas fir reproduction in the Rogue River Valley of Oregon.

On the Colville National Forest and the Colville-Spokane Indian Reservations in recent years, western larch has been dying from attacks of the fir flatheaded borer (Melanophila drummondi Kby.) and the western larch roundheaded borer (Tetropium velutinum Lec.).

The Sitka spruce weevil (Pissodes sitchensis Hopk.) continues to be active in killing the terminals of young Sitka spruce trees along the coast of Oregon and Washington. This is notably true of open-grown trees.

Defoliators.

Hemlock Sawfly (Neodiprion tsugae Midd.) Among forest tree defoliators, the hemlock sawfly staged the biggest outbreak of the five-year period. In August 1934, the State Forester's office reported an outbreak of this defoliator in western hemlock stands of eastern Linn County, Oreg., along the western slope of the Cascade Mountains. An examination of the area showed 10,000 acres heavily defoliated and some 50,000 additional acres lightly infested. Parasites were abundant and in the next two years helped to bring the outbreak completely under control. The loss of timber was small and confined to a few of the weaker suppressed trees, although the defoliated trees did lose considerable increment.

From rearings of this sawfly, 20 species of parasites were recovered. Of these, several were considered potentially valuable control agents for the introduced European spruce sawfly now causing widespread destruction of valuable spruce forests in northeastern United States and southeastern Canada. A large number of these parasites were shipped to the northeast for experimental liberation and colonization. Unfortunately, the parasites of Neodiprion tsugae have not proven well adapted to development on the European spruce sawfly.

Silver Spotted Halisidota (Halisidota argentata Pack.) This defoliator of young Douglas fir, Sitka spruce, lodgepole pine, and other conifers in western Oregon and Washington, which is prevalent in some localities nearly every year, was particularly abundant during the seasons of 1937 and 1938. It was found in various parts of western Washington and along the Oregon coast in large numbers, and attracted considerable attention. Although defoliation by it was extensive, no trees are known to have been killed.

Pandora Moth (Coloradia pandora Blake). The appearance of this pine defoliator in the Metolius basin of the Deschutes National Forest in the spring of 1933 caused some apprehension that a severe outbreak was impending. Moths were noted in flight in 1934 and a few caterpillars were present in 1935. Another flight of moths occurred July 15-24, 1936. Instead of an increase in this epidemic, as was thought likely, the moths decreased in numbers and the threat of an epidemic has apparently subsided.

Lodgepole Pine Needle Miner (Recurvaria n. sp.) An outbreak of this needle miner was noted around Lapine, Oreg., in 1933. During 1934 and 1935 this outbreak reached epidemic proportions and affected lodgepole pine over a wide area in the upper Deschutes basin. This species has one generation a year as contrasted with the Yosemite lodgepole needle miner which has one generation covering a two-year period. By 1936 this outbreak had largely subsided and the trees apparently suffered very little, if any, permanent injury. Bark beetles did not take advantage of the weakened trees as they did in the Yosemite outbreaks.

THE PRINCIPAL SHADE TREE INSECTS

While there are a large number of native insects which annually cause some damage to shade trees in the Pacific Northwest, the most serious pests are introduced species which have become well established in this region. Some of the more important are listed below:

Satin Moth (Stilpnotia salicis L.)

This European insect, which has been known to be present in the State of Washington since 1922, has caused extensive defoliation of Lombardy, Carolina, silver, and native poplar, and native willows in the Puget Sound region, particularly from 1930 to 1935. During this period several European parasites of the satin moth were colonized in Washington by the Bureau of Entomology and Plant Quarantine, and by 1935 at least three of them had become well established. Subsequently, a marked decrease of satin moth infestation occurred so that by spring of 1938 only a few larvae could be found in the old centers of infestation.

The satin moth was first discovered in Oregon in August 1934 near Gervais, where it had evidently become established two or three years previously. Since its discovery, satin moth has been found widely scattered over the northern part of the Willamette Valley from Portland to Albany. Now one of the introduced parasites is abundantly established and two others are present in smaller numbers. A heavy winter mortality during the 1937-38 season reduced the satin moth population in Oregon to a very low level.(34)

Poplar and Willow Borer (Cryptorhynchus lapathi L.)

For many years this destructive European weevil, which attacks poplar and willow, has been present in Washington and British Columbia. In July 1933 it was first noted in Oregon infesting native willows along the Willamette River near Portland. Since then it has been found attacking ornamental willows in the vicinity of Portland and as far south as Wilsonville. In the last two years infestations have become increasingly severe. Apparently, willows in this region are doomed to suffer severely from its attacks and to become sprouting clumps of brush instead of individual trees. Control measures are difficult to apply and not particularly effective.

Elm Leaf Beetle (Galerucella xanthomelaena (Schr.)).

The elm leaf beetle is well established in western Oregon. In Portland it annually defoliates elm trees unless they are thoroughly sprayed. Because of lack of funds in 1935 and 1936, heavy infestations developed in Portland on park and street trees. An intensive spray program in 1937 reduced this infestation so that only a slight amount of leaf injury was noticeable.

Gall Aphids (Adelges spp.)

Frequent reports of damage by Cooley's gall aphid (A. cooleyi Gill.) on Sitka and Engelmann spruce, and on their alternate host, Douglas fir, have been received. The cone-shaped galls produced on spruce by this insect commonly occur every year and do not appear to vary much with the seasons.

The gouty gall aphid of white fir (A. piceae Ratz.) was found causing considerable injury to ornamental white firs on an estate near Salem, Oreg., during the summer of 1937.

The hemlock gall aphis (A. tsugae Ann.) was found in 1937 killing shaded lower branches of western hemlock planted as an ornamental hedge in Portland.

THE PRINCIPAL FOREST PRODUCTS INSECTS

Insects which attack finished and unfinished wood products appear to be always with us. Until 1936 no attempt was made to measure the importance or abundance of these pests from year to year. Since 1936 a record has been kept of the complaints and requests for control information reaching this office. A summary of the requests for 1937 has been made by Furniss.(7) The insects in this group which have been most conspicuous in reports of damage to this class of forest products are listed below.

Carpenter Ants.

Homes infested with carpenter ant colonies are very numerous in the Pacific Northwest. Judging from the large number of complaints received by this office, ants outrank termites as household pests nearly 3 to 1. Studies are now under way to determine satisfactory control measures under the varying conditions found in infested homes.

Termites.

Termites are occasionally encountered doing damage to wood structures in this region. In 1936, the Portland Dock Commission reported $25,000 damages to Municipal Terminal No. 4 caused by attacks of the damp-wood termite (Zootermopsis angusticollis Hag.). Usually the damp-wood termite confines its attacks to rotting wood. When this is the case, elimination of the cause of the rot and the replacement of the unsound wood is generally sufficient to control the termites. In 1937 the western subterranean termite (Reticulitermes hesperus Banks) was found attacking floors of a Portland home where the foundation had been built on a level with the ground line.

Powder-post Beetles.

These beetles, principally Lyctus spp., are frequently found attacking stored hardwood products, oak flooring, and furniture. In the last two years there has been a notable increase in the number of requests concerning this beetle. Hadrobregmus gibbicollis Lec. was found in 1937 attacking dry foundation timbers of an old house in Puyallup, Wash.

Buprestids.

Many reports of damage caused by buprestid wood-boring larvae (Buprestis aurulenta L. and B. langi Mann.) to Douglas fir flooring and interior and exterior finish were brought to our attention. These insects are abundant forest products pests in the Pacific Northwest.

Ambrosia Beetles.

Ambrosia beetles in Douglas fir logs left in the woods or placed in mill ponds have caused damage estimated at $25,000 a year to one company alone. This problem is being studied to find suitable remedies.

PART II

WHAT HAS BEEN THE INSECT DAMAGE TO FORESTS OF THE PACIFIC NORTHWEST 1933 - 1938

The forests of Oregon and Washington show a wide variation in susceptibility to insect attack and in resultant damage. This is largely due to the preference of insects for certain host trees, but also reflects the influence of environmental and climatic conditions. Greatest damage occurs in the pine forests of the semi-arid portion of these states, while the rain forests along the coast are relatively immune from attack by tree-killing insects.

In the last five years, the stands which have suffered most from insect damage are the ponderosa pine stands east of the Cascades, the lodgepole and western white pine stands along the Cascade Range, and the Douglas fir stands in and near the Tillamook burn of western Oregon.

INSECT DAMAGE BY FOREST REGIONS

The Douglas Fir Region.

Ordinarily the Douglas fir forests of western Oregon and Washington are relatively free from serious insect damage. Occasionally as an aftermath of fire, blow-down, or other disturbance, the Douglas fir beetle may become aggressive and kill considerable timber (see pages 4-5). In southern Oregon, severe drought conditions may bring about unusual insect activity, (15) but normally the more important problems in this forest region are occasioned by wood borers in forest products, such as ambrosia beetle damage to logs and wood borer deterioration of fire-killed trees. As a result of the Tillamook burn of 1933, insect damage in both living and dead timber has greatly increased the more normal loss of the Douglas fir region.

The Spruce-Hemlock Region.

The spruce-hemlock forests along the coast of Oregon and Washington are occasionally subjected to serious damage by such insects as the hemlock looper, the Sitka spruce aphis, and the Sitka spruce weevil.

Since the last outbreak of hemlock looper in Pacific County, Wash., during 1931-33, no further evidence of this defoliator has been noted along the coast, but a flight of moths was observed on the Mount Baker National Forest of northern Washington in October 1938, which may portend a new outbreak in that vicinity.

All along the coast, terminals of young, open-grown Sitka spruce show repeated damage from work of the Sitka spruce weevil. The Sitka spruce aphis has been very inconspicuous in recent years.

The Ponderosa Pine Region.

The various species of trees found in the ponderosa pine region are attacked, injured, and killed by many different species of insects. White firs frequently suffer heavy losses from engraver beetles, and many trees are killed each year, especially in the Blue Mountain Subregion. During the past five years, however, no widespread outbreak has occurred comparable to that of 1932. In northeastern Washington, Douglas fir and western larch have continued to die from attacks of flatheaded and roundheaded borers. At the present time forest officers on the Colville National Forest are having a difficult time locating areas containing sufficient Douglas fir to warrant making tie sales—a result of continued depredations by forest insects. White fir and Douglas fir over large areas on the Malheur National Forest were partially defoliated by the Douglas fir tussock moth during 1938.

Over the region as a whole, however, these losses have been comparatively unimportant. By far the greatest insect damage to forest trees in this region has been the mortality of ponderosa pine caused by the western pine beetle and associated insects. Since this problem is very large, its various aspects will be discussed in the sections which follow.

Pine Beetle Damage in the Ponderosa Pine Region. For the past two or more decades, the ponderosa pine stands of eastern Oregon and Washington have suffered repeated outbreaks of tree-killing bark beetles, collectively referred to as "pine beetles". The total damage from this source has run into billions of board feet, and represents a terrific monetary loss. The commercial saw timber of many stands has been so badly depleted that they have lost most of their value as logging units.

Because of the extent and seriousness of these losses, and the economic importance of ponderosa pine, special attention has been given to this pine-beetle problem by federal and private agencies. Recent accomplishments in this field, together with a review of present conditions in Oregon and Washington, will be presented in considerable detail in the following sections and paragraphs.

The Regional Pine Beetle Survey. In the ponderosa pine region each year for the past several years, the Forest Service, Office of Indian Affairs, and Bureau of Entomology and Plant Quarantine have combined forces to conduct a comprehensive regional pine beetle survey covering the commercial ponderosa pine forests of eastern Oregon and Washington. Private timber protective agencies have cooperated in this undertaking by making available their records of spotting and control work conducted on their lands.

The purpose of these annual surveys has been primarily to determine the trend of bark beetle activity, where control work needed to be undertaken, and the results of previous work. The surveys have also furnished valuable information as to areas of high beetle hazard which needed either control or early selective cutting of high-risk trees. The Forest Insect

Laboratory at Portland has outlined the general survey methods to be followed, has given technical supervision to the work, and has acted as a clearing house to bring together the records from all sources and interpret the results.

From 1931 to and including 1934, such survey work as had been undertaken was conducted by the personnel of the Forest Insect Laboratory, with some assistance from regular forest officers under the Administrative Study Program of the Forest Service, and after the inauguration of the CCC camps, with some assistance from CCC enrollees assigned to this work. The Office of Indian Affairs, under the direction of Harold Weaver, had undertaken surveys on two of the five Indian Reservations in the pine region.

In 1935, the Forest Service set up funds for the first comprehensive beetle survey of National Forest lands in the pine region. Five crews of three men each were placed in the field about the first of August and cruised some 113,400 acres of check plots and line strips during the next two months. This work, combined with intensive surveys by the Office of Indian Affairs on the Yakima and Warm Springs Indian Reservations, and cruises by the Bureau of Entomology and Plant Quarantine on the remaining private and Indian lands, resulted in a 3.0 percent cruise of some 4,536,000 acres of commercially valuable ponderosa pine forests.

In 1936, a similar regional pine beetle survey was conducted by the three agencies, using temporary employees hired by the Forest Supervisors. In this survey, 125,272 acres of check plots and strips were intensively covered, representing a 2.8 percent sample of the 4,531,500 acres involved.

In the 1937 beetle survey a somewhat different plan was followed. Forestry students enrolled in the CCC organization were assigned to this work by the Forest Service. On Indian Reservations, Indian CCC enrollees were also used. The work was therefore confined to the recruising of check plots, and 54,935 acres were cruised for insect losses and a 10 percent cruise of the living stand was made. This represented about a 0.6 percent coverage of some 8,600,000 acres included within the survey area. In addition to the plot work, observational surveys were made on the remainder of the area.

The survey of 1938 was conducted along similar lines. Four three-man crews were employed by the Forest Service for a period of two months, and one additional three-man crew was employed by the Bureau of Entomology and Plant Quarantine. For the first time in this work, all of the men employed were either Junior Foresters, seniors in forest schools, or recent forestry graduates. This made possible a much higher class of work than had been possible in previous years. The Office of Indian Affairs also received increased funds for beetle control and surveys which enabled them to make detailed surveys on the Klamath, Warm Springs, and Yakima Indian Reservations. During the 1938 season, 77,562 acres of check plots were intensively cruised, and together with observational surveys completed by experienced entomologists, represented complete coverage of 11,000,000 of the 11,400,000 acres included in ponderosa pine types of the two states.

Losses of ponderosa pine determined from the intensive cruising of check plots during the course of these surveys from 1934 to 1938 are shown in a series of tables in the Appendix (tables 1 to 6, incl.). As will be noted, these intensive surveys have covered from 43,000 to 77,500 acres of virgin ponderosa pine each year, representing from 0.4 to 0.7 percent of the total commercial ponderosa pine acreage in the region.

From these cruises, supplemented by observational surveys and in some years by strip counts, broad general estimates of the losses by infestation areas, natural divisions, and subregions have been developed. In the previous report, (16) such estimates were made for 1931, 1932, and 1933. The 1933 figure was tentative, since it was based on a survey made during the attack period in the summer of 1933, and is therefore revised in this report to conform to data obtained in subsequent cruises. Total loss estimates for the period 1933-37 are given in table 7 in the Appendix in terms of: (1) Percent of mature and overmature stand killed year by year, (2) the total percent killed in the last five-year period, and (3) the total percent for the past decade.

Total Pine Beetle Depletion of Ponderosa Pine. Since 1921, when surveys in southern Oregon were first started, it is estimated that pine beetles have killed an average of 826,000,000 board feet of ponderosa pine per year in east-side forests of Oregon and Washington, or a total of over 14 billion board feet during the 17-year period from 1921-37, inclusive. This loss of ponderosa pine timber is almost as much as has been cut by pine sawmills in the region during the same period. Because of the rapidity with which the sapwood of beetle-killed ponderosa pine trees becomes blue-stained, the salvage of such trees is rarely profitable. However, a small amount of this timber has been cut for firewood.

Since 1931, when the regional bark beetle survey was extended to cover portions of the entire ponderosa pine region in the two states, the total estimated damage has amounted to approximately 5,800,000,000 board feet. The distribution by years and by states is illustrated in chart 1. As will be noted from table 8, the average annual loss during the period 1921 to 1930 was maintained during the period 1931 to 1937, even though the loss since 1933 has rapidly declined. In recent years, the heaviest infestation occurred in 1932, with a loss estimated at 1,710,000,000 board feet of ponderosa pine. In 1937 when the low point was reached, the loss was estimated at 380,000,000 board feet, which is about 0.5 percent of the total ponderosa pine stand in the two states.

Much of this destruction has occurred in accessible and high-value timber. What this loss means to the various federal and private timber owners is shown in chart 2.

Relation of Ponderosa Pine Depletion to Sustained Yield. Not only does this continuing beetle damage represent a tremendous destruction of capital values, but it also raises a serious threat to sustained yield forest management which is so vital to stabilization of forest industries and the communities dependent upon them.

With the demand for ponderosa pine saw logs already exceeding current growth rates, the possibility of balancing depletion by growth is rendered doubly difficult, if not impossible, by allowing pine beetle depletion to rival timber utilization.

The current situation in respect to the relationship between growth and the various sources of depletion in the ponderosa pine region is graphically presented in chart 3.

It will be noted from chart 3 that the amount of saw timber cut and killed by beetles has totaled about two billion board feet a year for nearly two decades, while the current growth has been only about one-third as much. This is much heavier drain than the ponderosa pine resources of the region can afford to allow without serious depletion of the timber capital. Stopping the loss from beetles would very materially help in bringing the sustained yield budget nearer a balance.

As will be noted, of the unproductive causes of drain, the damage from beetles far exceeds all others. Fire losses have been brought to a minimum through intensive protection effort on the part of all forest agencies. Nothing can be done to stop the loss from wind. The greatest hope of further reducing unproductive drain lies in the direction of controlling the beetle depredations. At present this problem is receiving the least attention.

The General Trend of Ponderosa Pine Losses. As a result of the action of various natural control factors, pine beetle epidemics rise and fall during a period of years. In southern Oregon our records show three epidemic periods between 1917 and 1937. The first outbreak reached a peak about 1917 or 1918, then declined to a low in 1923. The second epidemic developed during the period 1924 to 1929, with a high point in 1927. The most recent beetle outbreak started in 1930 and reached a high point in 1932, from which it declined to a low in 1937.

This same general trend of infestation for the period 1931 to 1937 was similar in all parts of the region, but varied slightly by subregions (chart 4), according to records from survey plots which, in 1931, were extended to forests north of the Klamath Subregion. Evidently encouraged by drought conditions and poor tree growth, and aided by a windstorm in April 1931 which laid down an abundance of host material, the 1932 outbreak developed simultaneously throughout the pine region. The peak infestation of 1932 was suddenly checked by an extremely cold winter in 1932-33. In eastern Washington and in the Blue Mountains of Oregon the infestation continued to decline and by 1934 had dropped to an endemic status, which has been maintained up to 1938. In the Deschutes and Klamath Subregions, the broods succeeded in partly recovering from the set-back of the lethal temperatures of 1932-33 and showed an increase in 1934. But this increase was short-lived. Other factors came into play and the outbreak again began to subside, until in 1937 it reached the lowest stage that has been noted since records were started in 1931.

The striking change in infestation conditions as between 1932 and 1937 is graphically shown by the two infestation maps, Figures 1 and 2. In 1932 the major portion of the ponderosa pine region in the two states showed moderate to heavy epidemics. In 1937 most of the region showed normal infestation, with moderate to heavy epidemics confined to the lower elevations or fringe-type timber.

The 1938 infestation, as indicated by plot records (chart 4), showed a marked increase in all four subregions, possibly as a result of the very mild winter of 1937-38, which allowed the overwintering broods to come through without abnormal casualties. On some forests there was a sharp break between the summer and overwintering generations, but on others, notably the Klamath and Warm Springs Indian Reservations and the Bly District of Klamath County, the overwintering broods were abundant and aggressive. On these areas control operations were started in the fall of 1938 and continued during the winter and spring of 1938-39.

Just why pine beetle epidemics rise and fall, sometimes rather suddenly, is as yet an unsolved research problem. Obviously it must be the result of action by various natural control factors, such as temperature, moisture, tree resistance, and predaceous enemies, for control efforts made by man have not been extensive enough to cause a decline in infestation for the region as a whole. However, the role of these various natural control factors and how they are interrelated is not as yet fully understood. Drought conditions and poor tree vigor, coupled with an increase in beetle population which developed in the extensive windfalls of 1931, offer an explanation for the peak infestation of 1932. Heavy beetle mortality during the cold winter of 1932-33 adequately explains the sudden drop of infestation in 1933. The subsequent decline to 1937 may have been influenced by better moisture and tree growth plus additional cold winters in 1935 and 1937. The mild winter of 1937-38 is thought by some to be the reason for the increased beetle activity in 1938, but none of these climatic and environmental factors fully explain the trend of infestation from year to year, which to a large extent must be due also to biological factors affecting beetle abundance.

Lacking a full understanding of the influence of these various natural control factors, there is no adequate basis upon which to hazard a prediction as to the trend of infestation during 1939. In general, infestation is at a low stage and even though it increases during 1939, very few areas should become highly epidemic. Since tree growth and vigor have greatly improved, it is believed that losses will continue to remain at a comparatively low level, except on some of the high hazard areas of the Klamath Subregion.

The General Distribution of Ponderosa Pine Losses. In the past decade, all parts of the ponderosa pine region of Oregon and Washington have been affected by beetle depredations, but to an unequal degree. The heaviest mortality has been at the lower elevations where poor site and moisture conditions have been the most critical, but even good sites and

fine bodies of timber have been seriously damaged. The distribution of losses, as determined by snag counts made in 1937, is shown by natural infestation areas in chart 5. As will be noted from this chart, these losses, which roughly represent those occurring in the decade 1928-1937, have ranged from a high of 24 percent of the stand on 270,000 acres of the Snow Mountain Area to a low of 5 percent on several Washington and Oregon areas. On smaller areas, of a section or more in extent, the spread has been even greater. One check plot of 640 acres in the Bly Area lost 60 percent of its stand between 1921 and 1937. Other check plots have shown a gross loss that is less than the growth rate. The average loss on Oregon forests, as shown by these 1937 snag counts, represented 11.2 percent of the stand killed in about 10 years, while in Washington 8.7 percent of the stand was killed during this same period.

Since both the amount of pine beetle damage and the trend of infestation have varied in different parts of the ponderosa pine region, these variations will be discussed separately by subregions and administrative forest protective areas.

INSECT DAMAGE BY FOREST SUBREGIONS

The Eastern Washington Subregion.

The ponderosa pine forests of eastern Washington have suffered very unequally from pine beetle damage in recent years. Many areas show gross losses which are less than the growth rate, while heavy damage has occurred on a few areas, notably in Klickitat and Yakima Counties, of southern Washington. In the last five years pine beetle damage has dropped to endemic levels for practically all areas.

One striking characteristic of pine beetle outbreaks in Washington is the suddenness with which they have developed and then declined (see chart 4). The outbreak of 1932 followed a severe windstorm of April 1931, developed losses exceeding six percent of the stand in some areas during 1932, and then subsided to endemic levels by 1934. As in other parts of the pine region, there was a marked increase in 1938 infestation in practically all areas.

The Blue Mountain Subregion.

Damage by pine beetles in the Blue Mountain forests of northeastern Oregon and southeastern Washington has been comparatively light except for the period 1931-33. Similar to the trend of eastern Washington (see chart 4), this outbreak flared up suddenly and developed tremendous losses in 1932. On one 80-acre plot on the Ochoco National Forest, over 17 percent of the stand was killed in that one year. Then following the cold winter of 1932-33, the epidemic subsided as quickly as it had developed, and except for rather limited areas has remained at a low level during the last five years.

This sudden flareup and quick subsidence of infestations seems to be characteristic of the more northern portions of the ponderosa pine belt. In the southern portions of the region, infestations go along year after year at more nearly the same rate.

The Deschutes Subregion.

The Deschutes Subregion takes in the forests of the Deschutes River Basin lying along the northern half of the Oregon Cascades, and includes the Deschutes National Forest, the Warm Springs Indian Reservation, the Mount Hood National Forest, and adjacent private timberlands.

This subregion was seriously affected by the windstorm of April 1931 and the beetle outbreak which followed in 1932, but in few places were losses as heavy as they were on the Ochoco National Forest or in Klickitat County, Wash. During the decade 1928 to 1937, as indicated by snag counts made in 1937, losses of ponderosa pine ranged from an estimated total of 6.0 percent of the stand in the Crescent Area to 18.0 percent on the Panhandle Area (see chart 5). With heavier losses occurring on limited areas, on the average of about 12.0 percent of the stand in the subregion was killed during this decade.

The recent trend of beetle infestation in the Deschutes Subregion has been similar to that of the other subregions, without showing such extremes. (See chart 4.) Losses did not reach as great a peak in 1932, were reduced by the cold weather of 1932-33, recovered slightly in 1934, and then dropped to a low in 1937. The 1938 infestation showed a 66 percent increase from this low, but in no portions of the subregion except on the Warm Springs Indian Reservation are aggressive infestations now in progress.

The Klamath Subregion.

The ponderosa pine forests east of the Cascade Summit in the Klamath and Harney Basins of southern Oregon, taking in parts of Jackson, Klamath, and Lake Counties, comprise the Klamath Subregion.

The pine forests of this subregion have suffered heavy losses from western pine beetle attack for a great many years. Beetle damage is known to have been in progress as early as 1911, when the Klamath Forest Protective Association first started its control work, but it was not until 1917 that serious epidemics became prevalent. In the last two decades, from 1918 to 1937, three epidemic outbreaks have taken place. These have resulted in serious depletion of the pine stands—in some cases amounting to as much as 60 percent of the original stand.

The trend since 1931 is shown in chart 4. One characteristic of infestations in this subregion is that beetle activity has maintained a fairly high rate of loss year after year, instead of showing a marked contrast between highs and lows, as has been characteristic of infestations farther north. Loss was highest in 1932, but has moderated since then.

The extent of future depredations by the pine beetle in this subregion can only be surmised. Most likely, losses will continue in the more susceptible areas until the overmature, decadent, and poor thrift trees have been killed out or removed by cutting so as to improve the growth rate of the residual stands. Selective cuttings offer the most hope in this direction. Private timber owners are rapidly liquidating their holdings, and one of the largest companies is taking into account the beetle risk factor in planning its cutting operations.

INSECT CONDITIONS ON ADMINISTRATIVE FOREST PROTECTIVE AREAS

Since the general conditions just discussed are not always strictly applicable to individual areas and forests, these are briefly covered in the following section:

National Forests of Region Six.

Chelan National Forest. Much of the ponderosa pine on this forest is mature or overmature and of slow growth rate. As a consequence, recent beetle damage has been somewhat higher than on other national forests of eastern Washington and is estimated to have totaled 10 percent of the stand during the past seven years. The loss for 1937 was estimated at 0.8 percent of the stand, which is considerably higher than what might be considered as a normal infestation.(62)

Colville National Forest. Ponderosa pine on the Colville National Forest is widely scattered in small patches. Growth rate has been fairly good and beetle damage has not been heavy. In the period 1931 to 1937, inclusive, it is estimated that 8.0 percent of the stand was killed. A low point in the infestation was reached in 1935 when 0.4 percent was killed, or about as much as estimated growth. A slight increase was noted in 1938.(64)

Deschutes National Forest. The pine timber on and adjacent to the Deschutes National Forest has suffered from pine beetle attack to a varying degree. In the southeastern portion of the forest the remaining commercial ponderosa pine stands have suffered more than pine of comparable quality and value elsewhere on the forest. These losses have amounted to 18 percent of the pine volume during the past decade. Plans have been laid for early cutting of the privately- and federally-owned timber in this southeastern portion of the forest on a light selection basis so as to remove the high hazard timber and leave the timber of better thrift for a later cut and for growth. Timber along the eastern and lower slopes of the Sisters Area, largely in private ownership, has shown comparable, heavy losses running over 20 percent of the stand in the marginal timber. The upper Deschutes Basin between the Paulina Mountains and the Cascades is a particularly cold area and has suffered comparatively little from beetle damage in recent years. The estimated loss during the past decade averages about six percent of the stand in this basin.

The epidemic trend on the Sisters Area was similar to that of Washington and the Blue Mountains (see chart 4). Losses quickly rose to a peak in 1932 and then rapidly subsided to a low in 1937. The trend on the Cabin Lake Area was more nearly like that of the Klamath Subregion, with some increase in 1934 followed by a drop to a low point in 1937, when the loss on the area averaged 0.5 percent of the stand.

Control work was undertaken by the Sisters CCC camp in the Metolius Unit of the Sisters Area during the winter of 1934-35 and completed the following winter. Artificial control by peeling and burning was also applied by ERA crews on the Pine Mountain Unit of the Cabin Lake Area during the winters of 1936-37. On the Sixteen Butte Unit of the Cabin Lake Area, control through salvage logging was worked out in cooperation with the Brooks-Scanlon Lumber Company in 1935-36. A sale subsequently made concentrated cutting on 50 percent of the stand most susceptible to beetle attack.

At present beetle infestation on the Deschutes is at a low stage, even though 1938 witnessed an increase on all areas.(65)

Fremont National Forest. Federally- and privately-owned ponderosa pine timber in and adjacent to the Fremont National Forest has suffered heavy depletion from pine beetle activity for the past two decades. In some portions of the Bly Area, losses have totaled over 60 percent of the pine. Over large areas from 15 to 30 percent of the stand has been killed. Taking the forest as a whole, the loss for the past 10 years has probably averaged about 15 percent.

The trend of bark beetle activity on the Fremont has been much the same as for the Klamath Subregion as a whole (see chart 4). Beetle depredations increased to a peak in 1932. Following the cold winter of 1932-33, infestation subsided in 1933, increased to epidemic proportions in 1934, then gradually declined to a low point in 1937. The 1938 infestation again showed an increase, with heavy losses occurring on portions of the Bly Area. Since this trend has been uniform over most of southern Oregon, it can only be attributed to natural factors affecting beetle populations and the resistance of host trees.

Control work was conducted by the Forest Service on the Silver Lake Area in 1931 and 1932 and on the Bly Area with CCC help in the winter of 1935-36. The Klamath Forest Protective Association has repeatedly conducted control operations on portions of the Bly Area, the most recent work being carried on during the past winter of 1938-39.(73)

Malheur National Forest. Like most of the Blue Mountain forests, the Malheur was badly hit by the pine beetle outbreak which reached its peak in 1932. The losses of ponderosa pine occasioned by this epidemic varied considerably in different portions of the Forest. For instance, one plot on the Sawtooth Unit showed a pine mortality of 11 percent on 160 acres in 1931 and 1932, while on the Summit Creek Unit losses were never much more than endemic. For the forest as a whole, it is estimated that approximately 10 percent of the stand has been killed in the past 10 years.

Since 1933, losses have been down to a low endemic level of about 0.5 percent of the stand per year. Only a slight increase was indicated for 1938.

Large-scale, light selection cuttings which remove 40 percent of the volume of the original stand are now in progress on this forest. Since most of the cut is confined to overmature and poor thrift trees, the reserve stands are not likely to suffer heavy beetle damage.

No control work has been conducted on the Malheur, and the low stage of present infestation does not indicate that control will be needed in the near future.

A new species of scale insect, identified as Matsucoccus bisetosus Morr., was found by Kachin and Welsh of the Pacific Northwest Forest and Range Experiment Station in the fall of 1938. Ponderosa pine reproduction on 400 acres of the Burns Ranger District was found to be so seriously stunted by this insect that no crop trees could be selected for release by thinning.

Mount Hood National Forest. The east-side district of the Mount Hood National Forest has had its ponderosa pine stands badly depleted by pine beetle epidemics in recent years, and many areas are now considered valueless as logging chances. At the lower elevations in marginal sites, the mature ponderosa pine stands have been nearly wiped out.

Practically all of this loss occurred during the period 1931-33. Since then beetle activity has rapidly declined, reaching a low point in 1937. No control work was undertaken during the epidemic and none appears necessary at present. However, losses on this forest are still fairly heavy and should be rather closely checked during the next season. On both privately-owned and national forest areas, beetle-killed ponderosa pine has been extensively cut for cordwood.

Ochoco National Forest. The ponderosa pine timber stands of the Ochoco National Forest and the private lands in and adjacent thereto were seriously depleted by the pine beetle epidemic which reached its peak in 1932. Losses on some areas for that one year alone exceeded six percent of the stand. The western portion of the forest comprising the Prineville Area, which includes lands of the Alexander-Yawkey Timber Company and the Ochoco Lumber Company, was hard hit during this epidemic, with a total of about 10.3 percent of the stand killed during the three-year period 1931-33. An aggressive control campaign was conducted by the Klamath Forest Protective Association and the Forest Service on the Alexander-Yawkey tract and adjacent national forest lands from 1931 to 1935; and the Mill Creek, Ochoco Creek, and Maury Mountain Units were later included in a control program conducted by the Forest Service.

The Snow Mountain Area in the eastern portion of the forest probably has been the most disastrously beetle-riddled area in Oregon. Snag counts indicate an average loss of 24 percent of the stand during the past decade. Since this area covers some 270,000 acres with a pine stand originally estimated at 2,300,000,000 board feet, the total loss in the last 10 years has

exceeded 550,000,000 board feet. No control was conducted on this area because of the tremendous extent of the 1932 epidemic. Following the general trend of Blue Mountain infestation, beetle activity has now subsided to an average annual loss of about .74 percent of the stand.

While 1938 witnessed a marked increase in beetle activity over 1937, late cruises showed that there had been a decided break between the summer and winter generations and that very few trees carried broods over the winter.(75)

Rogue River National Forest. In the ponderosa pine stands around the Rogue River Valley, western pine beetle infestations are known to have been active since 1914. During the last 25 years, these stands have been so badly depleted that there is little old-growth timber left. The depredations have been particularly severe in the Applegate River drainage south of Medford, Oreg. For this reason no detailed surveys have been conducted in these areas in recent years.

East of the Cascade summit, stands in the Fort Klamath and Beaver Marsh Areas have suffered only light or moderate pine beetle damage, due undoubtedly to better moisture conditions on these sites and a corresponding vigorous tree growth. The gross loss during the past 10 years has averaged from five to seven percent, which has been fully compensated by growth. Since 1933, the infestation trend in these areas has been similar to that for the Klamath Subregion. (See chart 4.)

Control work to protect timber along the Crater Lake Highway was undertaken on the Union Creek District in the fall of 1939. Three sections of ponderosa pine timber were affected and 83 trees, mostly in large groups, were felled, peeled, and burned by ERA crews.

Snoqualmie National Forest. Ponderosa pine in the portion of the Snoqualmie National Forest east of the Cascade Divide appears to be relatively young and of vigorous growth. In the 1937 cruise only 30 percent of the pine stand was classed as beetle-susceptible. Even during the last seven years of critical conditions, losses have been very low and are estimated at only 4.5 percent of the stand, with the lowest loss, amounting to 0.1 percent of the stand, estimated for 1936.(84)

Umatilla National Forest. During the period 1931 to 1933, ponderosa pine stands on portions of the Umatilla, particularly on the western edge of the forest in the Kinzua Unit, suffered heavy losses.(85) Since then, losses have dropped to an endemic or normal level and have remained so for the past three years.

Wallowa National Forest. As on the Whitman National Forest, early development of the lumber industry resulted in removing much of the ponderosa pine timber of high beetle hazard, so that remaining stands suffered comparatively little loss during the beetle epidemic of 1931-33. In the last few years, infestation of ponderosa pine by the western pine beetle only occurs in scattered areas where it remains in a low endemic status.

Wenatchee National Forest. Except for the epidemic losses which have occurred in the Entiat River Drainage, the ponderosa pine stands of this forest have been fairly free of beetle damage. Losses have been most apparent on the drier sites and at lower elevations. These have been due to the combined effect of beetles and drought. During the past seven years, losses have been low and are estimated at 6.0 percent of the stand. The lowest point was reached in 1936, when only 0.2 percent of the stand was estimated to have been killed. Since 1934, western pine beetle losses have been offset by annual growth. The remaining virgin ponderosa pine stands on this forest appear to be of low susceptibility to pine beetle attacks.(87)

Whitman National Forest. The early development of the lumber industry in this part of the region, due to the demands for mining, agriculture, and transcontinental railroad development, resulted in the removal of much beetle-susceptible timber in high hazard areas before the general beetle epidemic of 1931-33. As a consequence, losses were not heavy during this period, except in the Burnt River Basin and around Susanville, where approximately six percent of the stand was killed during the three-year period 1931-33. Since 1934, the infestation has subsided and is now at a low endemic stage over the entire forest.

National Parks and National Monuments of the Region.

During the past five years, observational insect surveys have been conducted in the forests of national parks and monuments of this region by local officers of the National Park Service, supplemented by an occasional inspection of hazardous areas by members of the Forest Insect Laboratory. This combined detection service has provided an annual check on forest-insect conditions in the parks so as to catch any outbreaks before they have had a chance to develop epidemic proportions.

Crater Lake National Park. Since the recent mountain pine beetle epidemic was brought under control in 1933, annual inspections of the park have brought to light no active centers of infestation in the lodgepole, western white pine, or white bark pine forests, and these stands appear to be exceptionally free from mountain pine beetle activity.

Along the southern boundary of the park, a few large ponderosa pines have been found infested with western pine beetle, but no infestation of epidemic character has developed in these stands.

As a part of the CCC program within the park, a few infested pines have been treated each year along roads and around recreational areas. This roadside cleanup not only serves the useful purpose of removing dangerous snags, but helps to maintain the beetle populations at an endemic level.(88, 89)

Mount Rainier National Park. While mountain pine beetle infestations have been under control in the important recreational centers of the park since 1933, new roads and park developments have opened up areas which were previously inaccessible and in which no beetle control had previously been attempted. Control on the more important of these areas is now being conducted by the CCC. (92)

Oregon Caves National Monument. An outbreak of the Douglas fir beetle in the forests surrounding the Oregon Caves was called to our attention by the Park Service in 1934. An examination (90, 91) showed large groups of Douglas firs had been killed a few years previously by a sudden outbreak of the Douglas fir beetle, and that as a result of blue-stain development in trees unsuccessfully attacked by the beetles, a few trees in these groups were continuing to die. No control was recommended, as the damage had already been done and attacks of the beetle had subsided.

Indian Reservations of the Region.

The Office of Indian Affairs, since the advent of the CCC-ID program, has carried out a very comprehensive and effective program of beetle surveys and control on three of the five Indian Reservations in the ponderosa pine region of Oregon and Washington. This work has been supervised by Harold Weaver of the Spokane Regional Office of the Indian Service, and the accomplishments of this program have been covered by him in a series of excellent reports. (37-39) A few highlights of this work are mentioned in the following paragraphs.

Colville and Spokane Indian Reservations. Previous to 1933, loss of ponderosa pine timber on these reservations as a result of pine beetle attack was very heavy, but since then only normal or endemic losses have prevailed. The loss for 1937 averaged 0.7 percent of the stand on the Colville and 0.9 percent on the Spokane Reservation. While the 1938 loss showed some increase over 1937, it was still below what might be considered as an epidemic status.

Annual surveys have been carried out by the Bureau of Entomology and Plant Quarantine in cooperation with the Indian Service, to detect any sign of beetle outbreaks, but so far no control work has been found necessary. (40-44)

Klamath Indian Reservation. Like other ponderosa pine stands of the Klamath Subregion, the forest of the Klamath Indian Reservation has suffered heavy losses from pine beetle attack during the last 20 years. It is estimated by Weaver that the loss during the period 1918-1938, inclusive, has totaled 1,699,000,000 board feet, or about 18 percent of the original ponderosa pine stand. This represents a loss to the Klamath tribe of approximately $8,019,280, at the average price of $4.72 per M, that has thus far prevailed for ponderosa pine on Klamath timber sales.

The most recent outbreak started from a low point in 1929, reached a peak in 1932, was temporarily halted by the cold winter of 1932-33, but increased again in 1934, and then subsided to a low point in 1937, as did other areas in the Klamath Subregion (chart 4). The 1938 infestation showed a strong increase in nearly all areas, and control work was inaugurated during the winter of 1938-39 in the Saddle Mountain and Calimus Butte Units. During the period from the fall of 1934 through the spring of 1938, a total of 11,685 trees on 113,480 acres were treated at a cost of $99,553.

While cold winters, increased precipitation, and better tree growth may reduce beetle infestations from what they have been in the last two decades, still it seems unlikely that infestations will drop to negligible proportions as long as overmature, slow-growing, beetle-susceptible trees predominate over large areas on the reservation. Extensive selective cutting operations are now in progress and will do much to relieve the present situation. Control work will be necessary in areas which are of high hazard and which cannot be reached in the near future by such selective logging operations. (45-48)

Yakima Indian Reservation. According to sample plot cruises, losses of ponderosa pine from beetle attack reached a peak on this reservation in 1933. Then, following an intensive control campaign conducted by the CCC-ID, these losses declined to a low point in 1937, when the estimated loss for the reservations was 0.5 percent of the ponderosa pine stand.

Control work was started in the fall of 1933, and the initial program continued through the winter and spring of 1935-36. By 1936, the infestation had reached such a low point that control work was temporarily halted. The annual beetle surveys were continued, however, and were followed by maintenance control in the fall of 1937 and another survey in 1938. During the four seasons of control work, 9,258 infested trees were treated on 89,880 acres. The 1938 infestation was found to be at such a low stage that further control work was not recommended. (56-60)

Warm Springs Indian Reservation. The history of pine beetle infestations on the Warm Springs Indian Reservation is much the same as on other areas of the Deschutes Subregion (see chart 4). While surveys were not started until 1934, it was evident that heavy ponderosa pine mortality had occurred in 1931 and 1932, had dropped slightly in 1933 as a result of subzero weather in the winter of 1932-33, and then had reached a new peak in 1934.

A comprehensive control program was outlined by the Indian Service forestry officials for the three Indian CCC camps assigned to this reservation. Work was started in the fall of 1933 and during the next five years under the immediate field supervision of Senior Ranger Harry Kallander, most of the 258,000 acres of ponderosa pine type were covered by control work, some areas being recleaned several times. Up to June 30, 1938, a total of 40,058 infested trees was treated on this reservation. This constitutes

not only the largest western pine beetle control project ever conducted on one area of ponderosa pine timber, but the most consistent effort to hold down pine beetle damage through repeated maintenance control effort. Check plot data have shown that losses have been reduced below those of other untreated areas, but there appears to be a tendency for infestations to renew aggressive activity as soon as work is discontinued on any treated area.

Since 1934, the infestation has declined year by year, until it reached a low point in 1937 with an estimated loss for the reservation of 20,500,000 board feet, or about 0.9 percent of the total ponderosa pine stand.

Another beetle survey was conducted by the Indian Service during the summer of 1938, which indicated that the infestation of 1938 would show a 25 percent increase over that of 1937. As a consequence, control work was continued during the fall, winter, and spring of 1938-39 by the CCC-ID camps. (49-55)

Private Protection Areas of Region Six.

Several large areas outside of national forests or other public ownerships are privately owned and are protected both from fire and insects by the timber owners themselves. The beetle situation on these areas has been followed through surveys made by the Bureau of Entomology and Plant Quarantine.

Klamath Forest Protective Association. Several large blocks of privately-owned timber in the Klamath Basin have been protected by the Klamath Forest Protective Association since 1911. The principal blocks are the Keno Area, lying west of Klamath Lakes, and the Bonanza and Bly Areas, east of Klamath Falls, within or adjoining the Fremont National Forest.

Surveys on these areas have been conducted since 1921, when they were started in connection with the "Southern Oregon-Northern California Pine Beetle Control Project". From 1917 to 1937 these forests have been swept by three major outbreaks of western pine beetle, each taking a toll of from 8 to 10 percent of the stand. The most recent wave of bark beetle activity started in 1930, reached a peak in 1932, and then declined to a low point in 1937. From 7 to 14 percent of the remaining stands were killed during this period. The 1937 loss, which was the lowest recorded since surveys were started in 1921, represented 0.3 percent of the stand in the Keno Area, 0.4 percent in the Bonanza Area, and 0.5 percent in the Bly Area. (98, 99)

Klickitat County Areas. Two large privately-owned ponderosa pine forests in Klickitat County, Wash., have been under observation by the Bureau of Entomology and Plant Quarantine since 1933. One, the Goldendale Area, is largely owned by the Eastern and Western Lumber Company; the other, the Glenwood District, includes the holdings of the J. Neils Lumber Company.

Following the blow-down of April 1931, these forests were hard hit by a beetle epidemic which built up to tremendous proportions during 1931 and 1932. On several 40-acre plots as much as 15 percent of the stand was killed in those two years, but the cold winter of 1932-33 took its toll of over-wintering beetles and the infestation subsided on these areas almost as quickly as it started. (See chart 4.)

From 1935 to 1938, losses remained at the low endemic stage of from 0.3 to 0.4 percent of the stand per year. This gross loss is well under the estimated replacement by growth. No control work has been conducted. (94-97)

PART III

WHAT IS BEING DONE TO CONTROL FOREST INSECT DAMAGE IN THE PACIFIC NORTHWEST

The problem of reducing forest insect damage is being tackled in four ways: (1) By annual detection surveys to determine the trend of infestation and the need for control work; (2) by direct control measures, such as the fell-peel-burn method of pine beetle control; (3) by silvicultural control through selective logging of high-risk trees; and (4) by research to improve present practices and, if possible, find new ways to deal with forest insect outbreaks.

Research work on these various problems is being carried on by the Forest Insect Investigations Division of the Bureau of Entomology and Plant Quarantine. Beetle detection surveys are conducted cooperatively by the Bureau, Forest Service, Office of Indian Affairs, National Park Service, and private timber owners. Control work is handled by the forest-protective agencies, with technical help furnished by the Bureau.

Chart 6 shows: (1) The present losses which it is hoped may be reduced by this effort; (2) the amount now spent by federal and private protective agencies for direct and indirect control; and (3) the amount spent by the Bureau in conducting new researches and in furnishing technical supervision of control projects initiated by forest-protective agencies.

THE PINE BEETLE CONTROL PROGRAM

Damage caused by pine beetles may be controlled either by eliminating beetle populations or by eliminating the host trees on which the beetles feed. For many years, direct control measures have had as their objective the eliminating of beetle populations. Burning infested bark, peeling, suncuring, or the use of penetrating oil sprays are some of the methods which have been used to kill pine beetles. More recently, attention has been given to the second possibility, i.e., that of eliminating susceptible host trees and thus indirectly accomplishing beetle control.

Direct Control Program, 1933-1938.

While much of the beetle loss is in the form of endemic, or low-severity infestations scattered simultaneously over large areas, and which are impractical to control, epidemic outbreaks can often be successfully handled in their incipiency. Control work against these destructive epidemics has been carried on by federal and private forest-protective agencies in ponderosa pine stands on a very large scale. Since 1933, most

of this control work on federally-protected lands has been done under the Civilian Conservation Corps or Emergency Relief Administration programs. A summary of the various control projects conducted in Region Six during this period is presented in tables 9 to 13, inclusive. The total amount of money expended on forest insect control during the period 1931 to 1938 is shown in table 14.

National Forest Pine Beetle Control Programs. During the past five years, the Forest Service has taken advantage of the emergency conservation programs to clean up beetle infestations on several badly infested areas of the Ochoco, Deschutes, and Fremont National Forests of Oregon.

On the Ochoco National Forest from 1933 to 1935, extensive control operations were conducted on the Mill Creek, Marks-Ochoco Creek, and Maury Mountain Units under the NIRA and CCC programs. Over 23,000 infested trees scattered over 158,000 acres were treated during these years at the estimated cost of $82,217. (75-80)

On the Deschutes National Forest,(66) the Metolius Unit of the Sisters Ranger District was treated by the Sisters CCC camp in the fall of 1934 and the spring of 1935, and again the following winter. On the Paulina Ranger District some control work has been conducted every year from the fall of 1933 to the spring of 1937, either by NIRA crews or in cooperation with the lumber companies having sale contracts in this area. During this four-year period some 17,150 infested ponderosa pine trees on 192,220 acres were treated at an estimated cost of $45,406.(66-70)

On the Fremont National Forest, the Bly CCC camp did a small amount of treating work in the fall of 1935. About 10,000 acres were covered and 519 trees treated at a cost of about $2,451.(74)

By 1937, beetle infestation on all of the national forest areas had reached such a low point that no further direct control work was recommended, and none was undertaken during the winter of 1937-38. Except for the treatment of 83 trees found on three sections along the Crater Lake Highway, in the Union Creek District of the Rogue River National Forest, no control work was undertaken on national forest land during the winter of 1938-39. However, if infestations continue to increase during 1939, some additional control work may be necessary.

Indian Service Pine Beetle Control Programs. As a part of the CCC program of the Interior Department, the Office of Indian Affairs has carried on a very comprehensive pine beetle control program on three of the large Indian Reservations of the ponderosa pine region. (See tables 9 to 14, inc.) (35-39)

The largest of these projects is the one which has been conducted on the Warm Springs Indian Reservation (49-55) during the period 1933 to 1938 (see page 24) and which is still under way. Up to June 30, 1938, a total of 40,058 infested trees had been treated on about 240,000 acres at an estimated cost of $197,178.

On the Yakima Indian Reservation, control work was discontinued in the spring of 1936,(60) after 8,904 infested trees had been treated and the infestation brought to a low stage. During the fall of 1937 it was necessary to treat an additional 354 trees on maintenance control. Since that time, no control work has been necessary.

Control work on the Klamath Indian Reservation has been carried on more or less continuously since 1921. From the fall of 1934 through the spring of 1938, a total of 11,685 infested ponderosa pines was treated on various units of the reservation.(46-48) Control has been conducted during the fall of 1938 and spring of 1939 on the Calimus Butte and Saddle Mountain Units.

No control work has been conducted on the Colville and Spokane Reservations, and at present pine beetle infestation in the forests of these reservations is down to a normal level.(40-44)

National Park Service Beetle Control Programs. In Crater Lake and Mount Rainier National Parks, the National Park Service has made effective use of its CCC camps in continuing maintenance control of pine beetle infestations in lodgepole pine, western white pine, white bark pine, and ponderosa pine stands. Infestations in the frequented areas of the parks are now well under control.(88, 89, 92)

Pine Beetle Control by Private Timber Owners. Private timber owners in this region have not only been greatly concerned over the inroads of beetle infestation in their valuable pine timber reserves, but have spent more liberally of their own funds for control work than have private forest owners in any other region of the United States.

During the period 1931 to 1938, $118,339 was spent by private timber owners in direct control effort. Most of this work was done in the Klamath region under the direction of the Klamath Forest Protective Association. This work is still in progress and undoubtedly will be continued as long as virgin stands continue to be depleted by beetle depredations.

For more than 10 years the Shevlin-Hixon Lumber Company operating in central Oregon has been systematically and thoroughly carrying on pine beetle protection work on an area which varied between 200,000 and 300,000 acres.

Beetle Control through Salvage.

Another method of destroying beetles infesting ponderosa pines of commercial size is to log out the beetle-killed trees, utilize the lumber, and burn the infested bark in the refuse burner at the mill, or drown the beetles in the log pond. This method has been used to some extent by the Shevlin-Hixon Lumber Company in its operations southeast of Bend, Oreg.;(67) but it has not come into general favor because the lumber from beetle-killed trees is degraded by blue stain, and unless an infestation is heavy and more or less concentrated in a small area, trees are too widely spaced to be salvaged except at an unreasonable expense.

Indirect or Silvicultural Control.

In the last few years, attention has been directed towards the possibility of controlling beetles through silvicultural or forest management methods. This involves (1) recognizing types of highly-susceptible trees before they have been attacked by beetles and the lumber blue-stained, and (2) logging sufficient timber of this character to make the operation economically feasible and give release to the remaining stand.

A classification of ponderosa pines according to relative susceptibility to bark beetle attack has been developed by Keen(8) and is now being used by the Forest Service and Indian Forestry Service in making light selective cuts of from 40 to 60 percent of the stand. These cuts remove those types of trees showing the highest risk and yet having positive realization value. Large timber sales on the Deschutes, Rogue River, and Malheur National Forests and the Klamath Indian Reservation have been made on this basis.

It is too early to say just how much reduction in beetle losses can be obtained by this method, but it gives promise of doing more permanent good than has been obtained from direct control measures used in the past.

THE FOREST INSECT RESEARCH PROGRAM

Considering the magnitude of the damage caused by forest insects and its important effect upon sustained forest production, the weapons now available for control are discouragingly inadequate. Direct beetle control measures are recognized as only temporary palliatives, and indirect control is still in the experimental stage. As yet, no practical control has been developed for dealing with forest defoliators. Thus the field of research in developing better methods of forest insect control is a large one and offers unlimited opportunities for originality and inventiveness.

The investigative effort of the Forest Insect Laboratory of the Bureau of Entomology and Plant Quarantine at Portland, Oreg., in the past five years has been directed towards the solution of those problems which are considered to be of the greatest economic importance in this region at the present time.(16-21) The major projects of this laboratory and their location in the field are shown on the accompanying map. (Figure 3).

A résumé of the more important accomplishments and results of these research projects will be presented in the following paragraphs:

Research Program in the Ponderosa Pine Region.

Cooperative Forest Insect Surveys. Since a major portion of the funds of the laboratory is allotted for cooperative surveys and assistance to federal forest agencies, the CCC, and private timber owners in the application of control measures, work of this character occupies a very important place in the program of the laboratory. The results of this work have already been covered by the discussions of this report.

Silvicultural Control of the Western Pine Beetle.

Relative Tree Susceptibility. Studies have been continued on the types of trees most susceptible to bark beetle attack, in order to determine what might be done in controlling infestation in ponderosa pine through selective cutting of high-risk trees and improving stand resistance. A tree classification [8] has been devised which is helpful in defining the more susceptible classes of trees, and this classification has come into general use throughout the region as a useful tool in timber marking.

Ponderosa pine stands cut on a selective basis are now being studied to determine the value of this indirect control method, and preliminary results indicate that it holds encouraging possibilities of reducing future losses in managed stands.

Relative Area Susceptibility. At present a study is under way to determine what conditions make one ponderosa pine forest more susceptible to beetle damage than another. Preliminary results have already indicated the extent to which such measurable factors as site, forest type, elevation, volume per acre, and growth rate are associated with heavy loss. Hazard maps have been prepared covering the Deschutes and Klamath Subregions which combine these factors so as to indicate the zones of greatest and least beetle risk. These maps should prove of value to timber owners in planning logging operations so that cutting may progress from the most hazardous areas into those least susceptible to beetle damage.

Control of the Western Pine Beetle through Low Temperatures. Extremely low subzero temperatures in the ponderosa pine region during the winter of 1932-33, [24] in November 1935 and again during the winter of 1936-37, [25,26] demonstrated that this form of natural control is occasionally very effective in temporarily destroying western pine beetle populations. Studies have been made to determine (1) the effectiveness of various bark thicknesses in protecting overwintering beetle broods from the lethal effect of cold weather, (2) the degrees of cold necessary to overcome this protection and cause beetle mortality, and (3) the effect of low temperatures upon various brood stages. In general, it was found [11] that when winter air temperatures in the pine region fall below -15° F. sufficient bark beetle mortality may occur to make artificial control work unnecessary. Temperatures lower than -45° F. may cause very nearly 100 percent mortality of western pine beetle broods.

Other studies have been conducted to determine how wide a variation in air temperatures may be expected in forest areas presenting various slopes and elevations so that records from nearby weather stations may be interpreted in terms of forest conditions.

While low temperatures may be effective in killing a high percentage of overwintering broods, it was found that such a reduction may be of short duration. The beetles apparently have remarkable recuperative powers and can build back to epidemic proportions in one or two seasons if other conditions are favorable for such an increase. An instance of such a build-up occurred in the second seasonal generation in the summer of 1933 following the extremely low temperatures of the previous winter.

Tree-Ring Studies.

In order to determine the trend of average seasonal precipitation in the pine region and its effect in encouraging or limiting bark beetle outbreaks, a detailed study of tree rings and the correlation with precipitation has been made.(9)

This study has shown no consistent downward trend of growth--indicating that over a period of the last 600 years precipitation has fluctuated around a general average. On the other hand, the past two decades have witnessed one of the most critical periods of moisture deficiency experienced during these last six centuries, which explains why the trees have been vulnerable to such heavy beetle epidemics as have recently occurred.

The prospect is for better-than-average moisture conditions during the next decade and a corresponding improvement in tree growth and resistance to beetle attack.

Research Program in the Douglas Fir Region.

Deterioration of Fire-Killed Douglas Fir. In the Douglas fir region one of the principal problems under investigation is the rate of insect-caused deterioration in the fire-killed trees of the large Tillamook burn, involving about 10-1/4 billion board feet of timber. The salvage of this timber is materially affected by progress of wood borer damage in the sapwood and heartwood, and the ultimate period of salvage will probably be determined in large part by the activity of the large Ergates larvae which extend their tunnels deep into the heartwood.(2) The habits of this insect and those of several smaller wood borers in relation to salvage operations are being studied.

Up to the present time,(5,6) five years since the fire, no Ergates beetles have been found and wood borer damage is progressing at approximately the rate predicted from earlier studies of some 60 burns throughout the Douglas fir region.(2) The results of this study will have wide applicability throughout western Oregon and western Washington.

Ambrosia Beetle Damage to Felled Timber. Ambrosia beetles, or pinhole borers, frequently cause serious damage to Douglas fir, spruce, and hemlock logs in the Douglas fir region. One operator reported a $25,000 loss from this cause in a single year.

Studies are now under way to determine the attack-free period during which it is safe to leave logs in the woods. Methods of handling logs to prevent such damage are also being investigated, as well as the use of sprays to protect the upper surface of logs lying in mill ponds. The ambrosia beetle problem is so general in the Douglas fir region that any steps toward its solution will have a wide and practical use.

Carpenter Ant Control. In the Pacific Northwest, carpenter ants are very troublesome in homes, often damaging timbers in a manner similar to that of termites. To a large extent they supplant termites as a source of worry to home owners. Various methods, previously suggested as carpenter ant control measures, are being tested to determine their effectiveness in this region.(33) Because of the diversity of situations in which carpenter ants are found, no one remedy has proven satisfactory under all circumstances. Of the various remedies tried, probably sodium fluoride dust is the most satisfactory. This is dusted in the nests or runways and is tracked by the ants to other portions of the colony, where it slowly kills members of the colony and discourages occupancy of the treated location.

PART IV

APPENDIX

CHARTS, FIGURES, STATISTICAL DATA AND LITERATURE CITED

EXPLANATION OF CHARTS

Chart 1. Pine beetle loss estimates as shown in this chart are based on beetle surveys as explained in the text. The losses shown are those of ponderosa pine throughout its distribution in Oregon and Washington, including portions west of the Cascade Range in southern Oregon.

Chart 2. This chart shows average estimated loss of ponderosa pine from beetle attack for the period 1931-1937, inclusive, by ownership and total value of this loss. Total ponderosa pine stand affected is shown in millions of board feet in left-hand column.

Chart 3. The basis for the figures used in this chart is as follows:

Growth. Normal growth for the period 1900-1935 based on computations by Mr. P. A. Briegleb of the Pacific Northwest Forest and Range Experiment Station for use in connection with the growth phase of the Forest Survey. Estimated growth for the period 1931-1937 obtained by reducing the above normal growth by 44 percent as determined by measurement of 1,939 increment cores made by the Forest Insect Laboratory.

Saw Timber Cut. Figures supplied by Mr. Herman Johnson of the Division of Forest Products of the Pacific Northwest Forest and Range Experiment Station from lumber census statistics.

Beetle-killed Timber. Figures derived from annual bark beetle surveys made by the Forest Insect Laboratory and cooperating agencies.

Windfall. A very rough estimate used in the Capper Report and modified by the judgment of several foresters.

Fire. Statistics for the period 1924-1935 compiled by the Forest Survey, Pacific Northwest Forest and Range Experiment Station. Statistics for the period 1931-1937 compiled by the Forest Insect Laboratory from reports of State Foresters and data supplied by the Regional Office of the Forest Service at Portland, Oreg., and field headquarters of the Office of Indian Affairs at Spokane, Wash.

Chart 4. The trend of pine loss as shown in this chart is based on the combined records from all survey plots within each subregion. Using the volume of loss in 1937 as a base, losses of other years were compared on a ratio basis.

Chart 5. Recent ponderosa pine depletion as shown by counts of snags (representing about 10 years of loss, 1928-1937) is shown in this chart. The vertical scale gives average percent of pine volume killed, while the horizontal scale indicates the relative size of the different areas. Data from pine beetle surveys, Forest Resource Survey check cruises, and Forest Experiment Station growth plots were combined to obtain the adjusted averages shown.

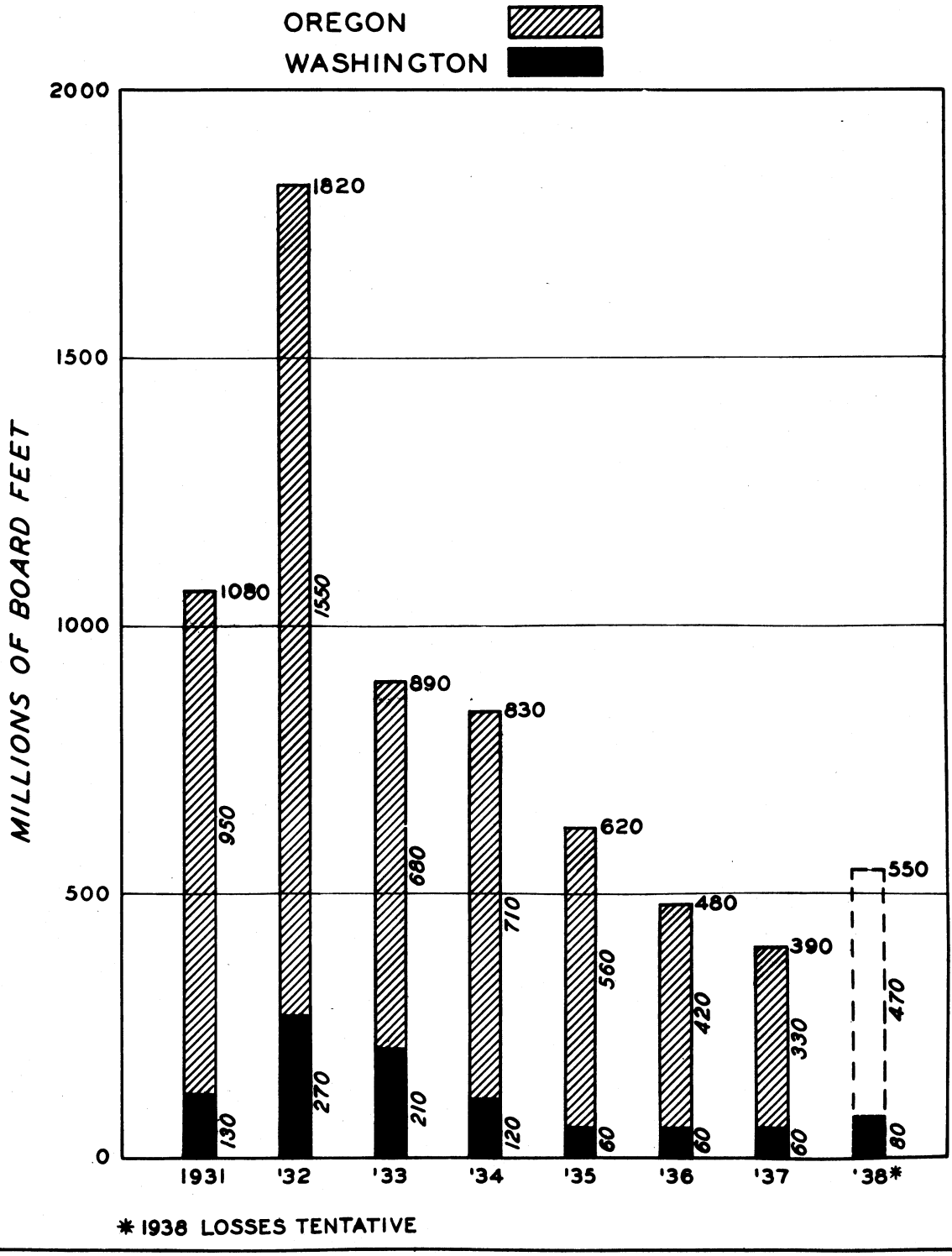
Chart 6. This chart compares the average annual value of ponderosa pine killed by beetles in Oregon and Washington with the amount spent for control and research during the period 1931-1938.

CHART I

TOTAL ANNUAL LOSS FROM PINE BEETLES

OREGON AND WASHINGTON

1931 TO 1938



* 1938 LOSSES TENTATIVE

CHART 2

AVERAGE ANNUAL VALUE OF PONDEROSA PINE KILLED BY BEETLES

OREGON AND WASHINGTON

DURING PERIOD OF 1931 TO 1937

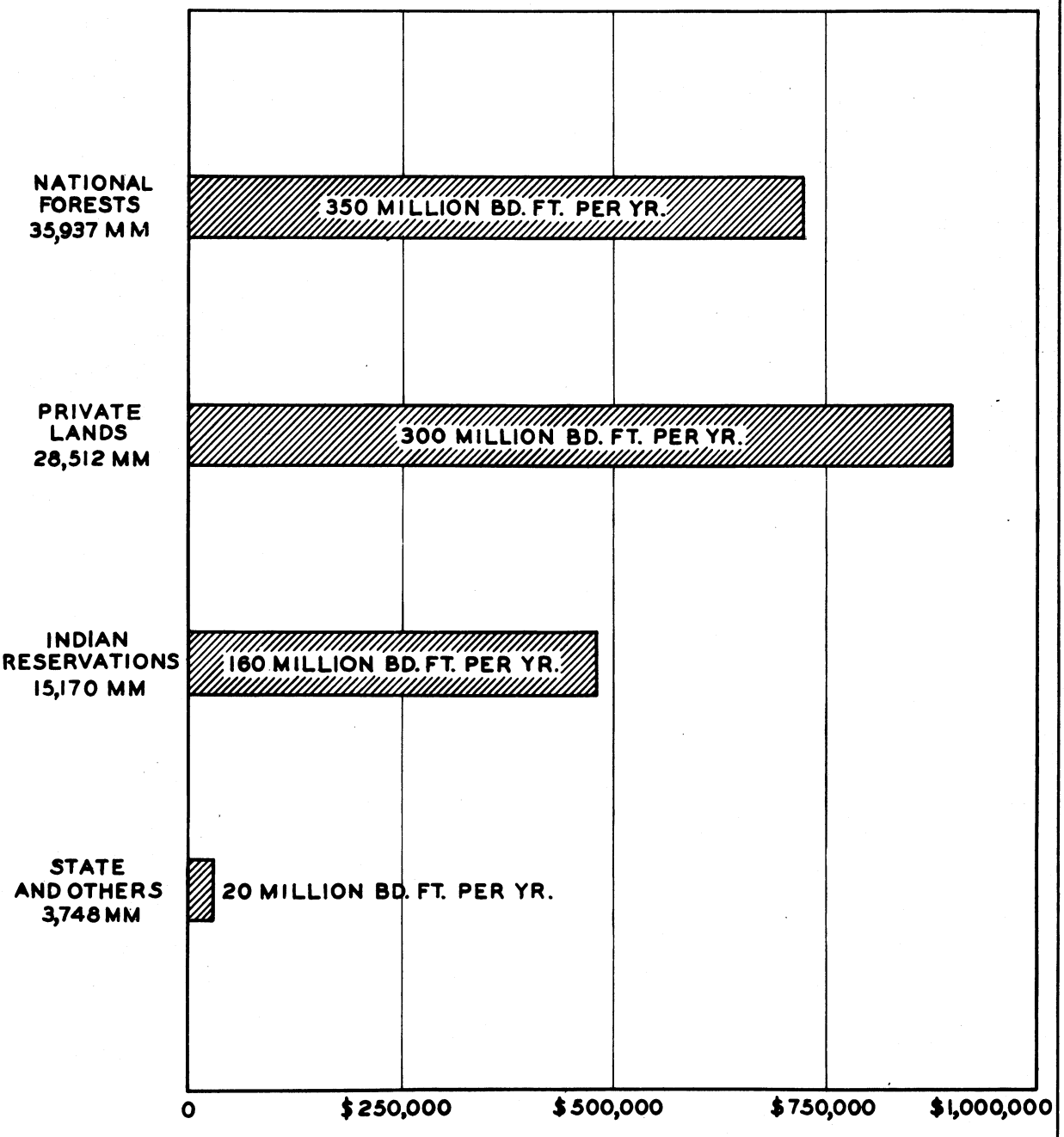


CHART 3

AVERAGE ANNUAL GROWTH AND DEPLETION OF PONDEROSA PINE

EASTSIDE OREGON AND WASHINGTON

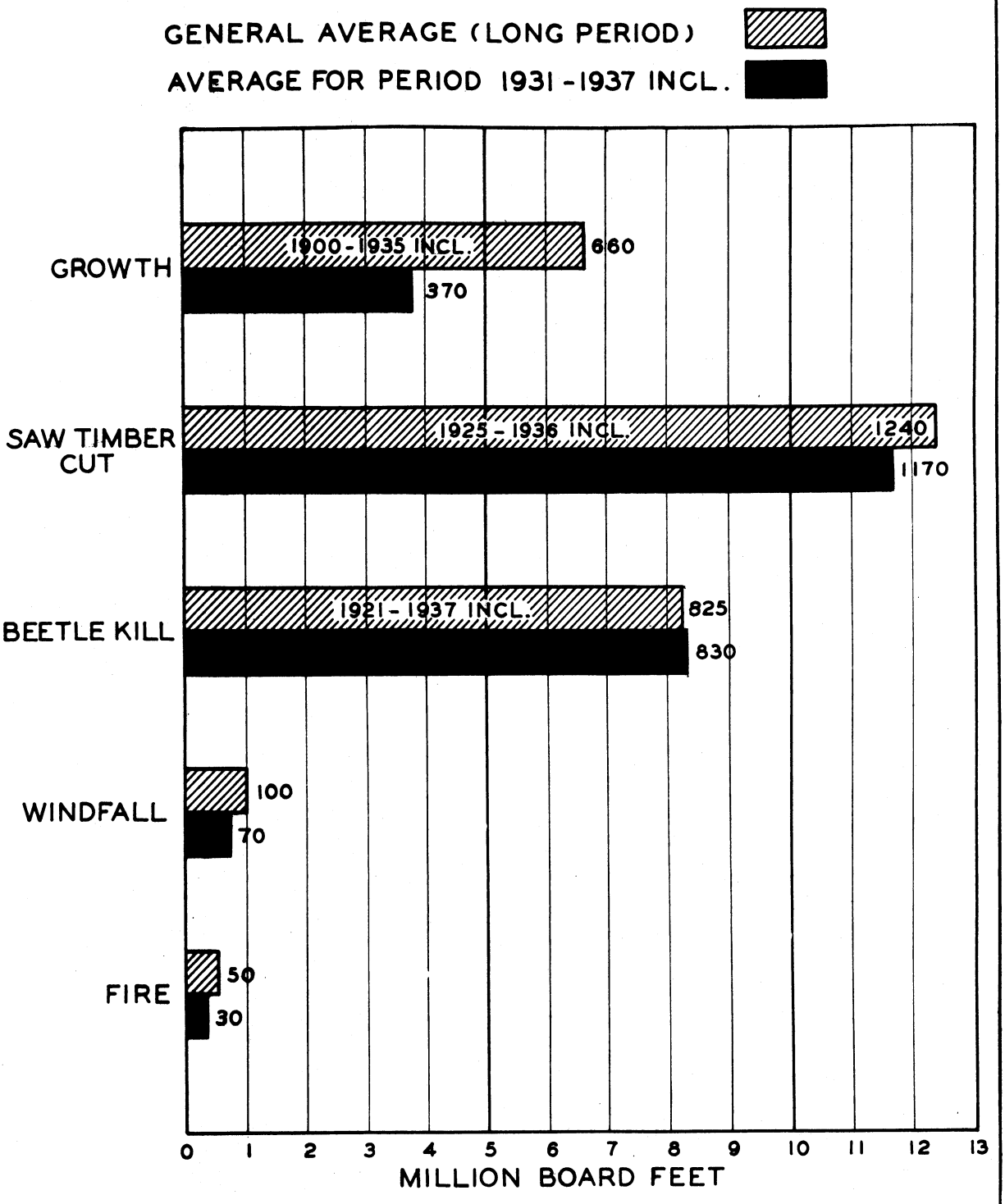
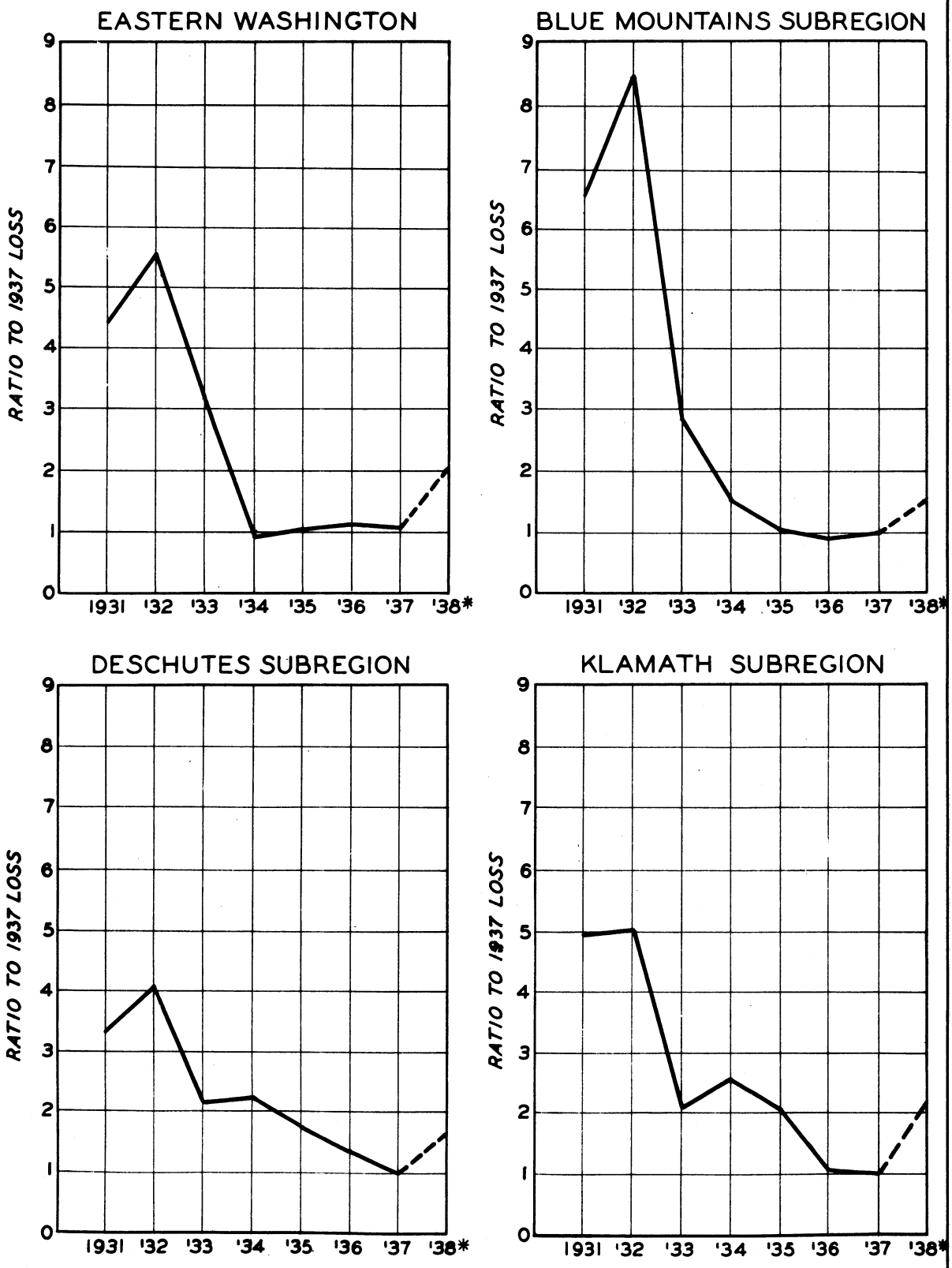


CHART 4

TREND OF PINE BEETLE EPIDEMICS ON SAMPLE PLOTS
FROM 1931 TO 1938



*1938 LOSSES TENTATIVE

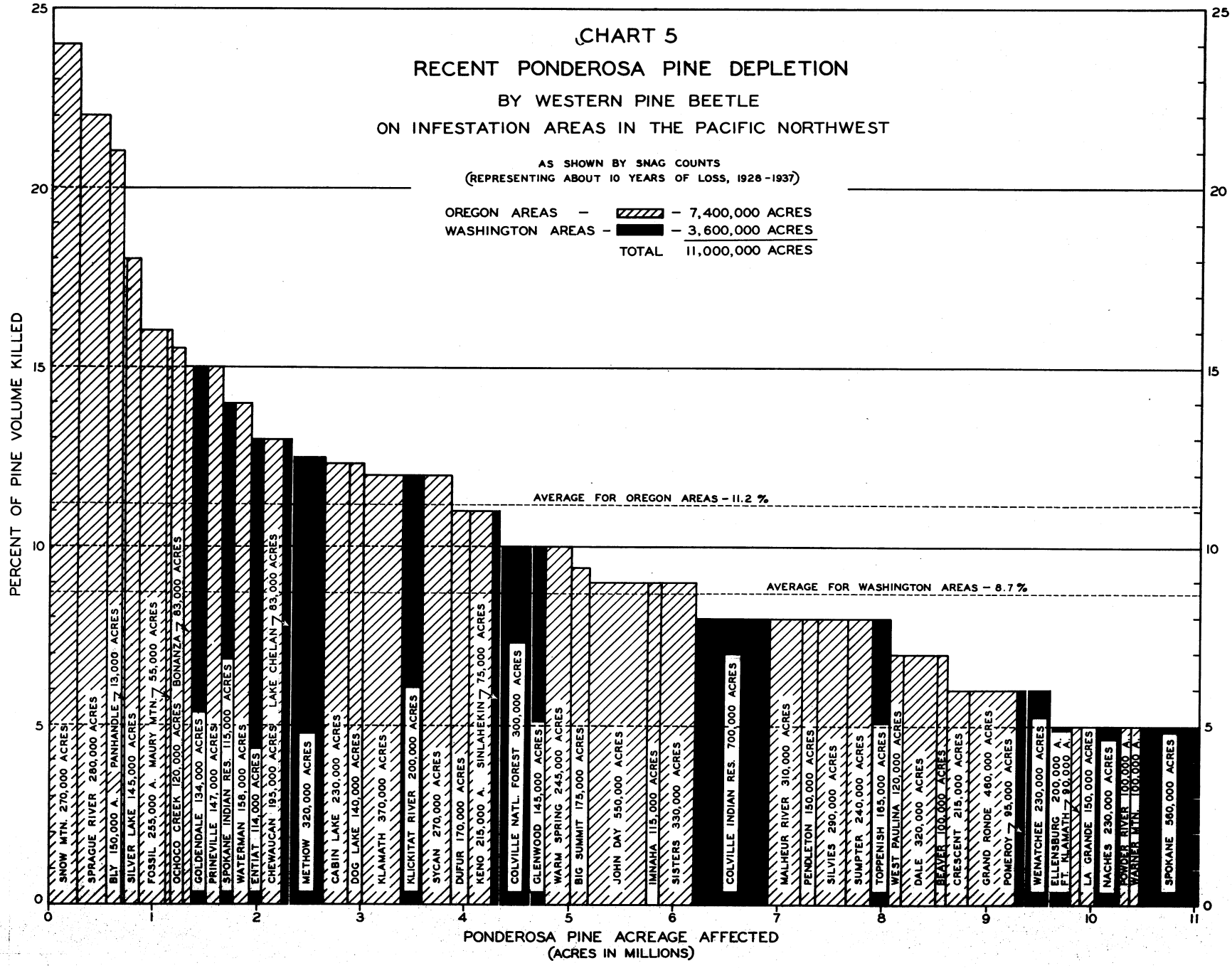
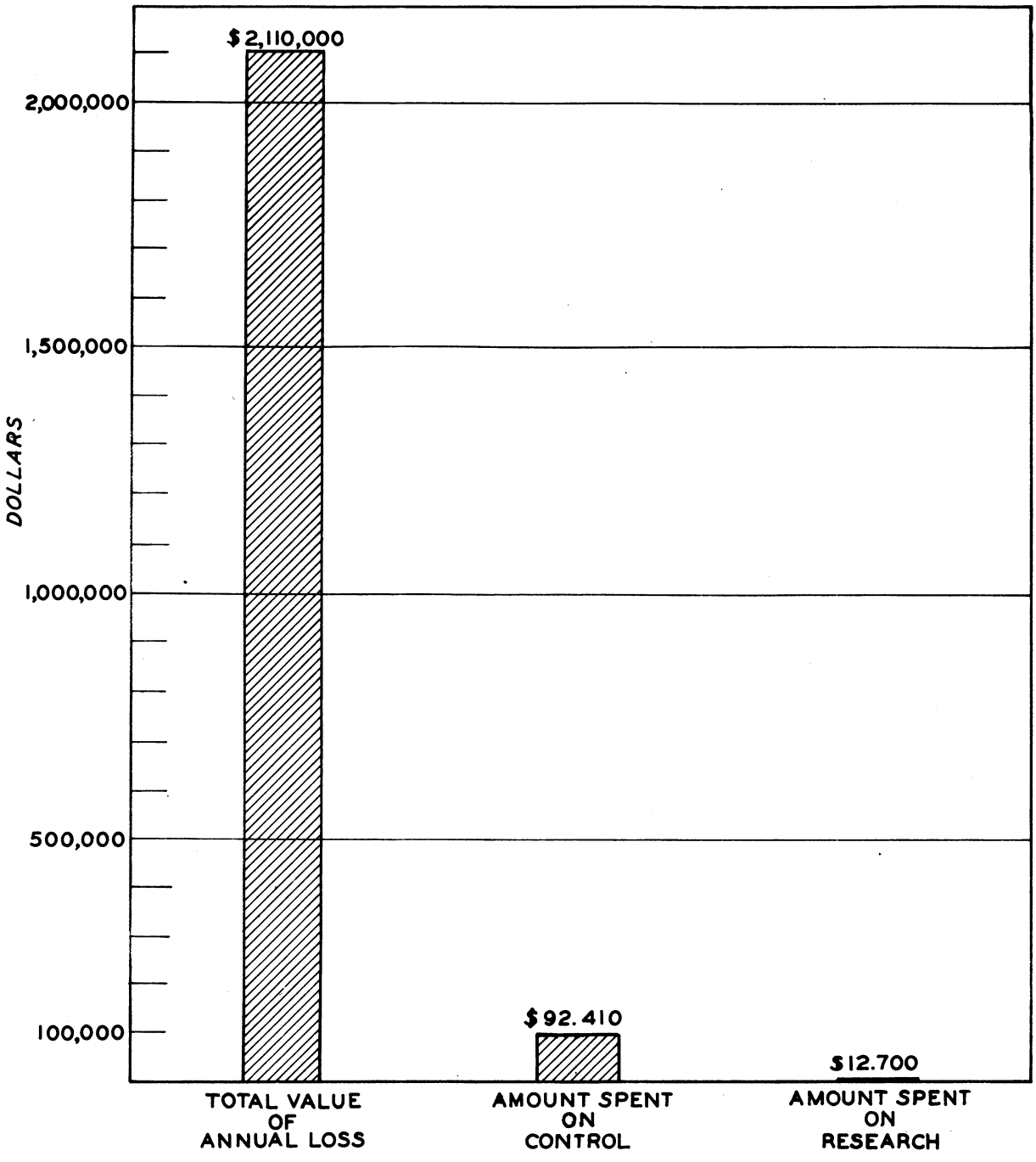


CHART 5
RECENT PONDEROSA PINE DEPLETION
BY WESTERN PINE BEETLE
ON INFESTATION AREAS IN THE PACIFIC NORTHWEST
AS SHOWN BY SNAG COUNTS
(REPRESENTING ABOUT 10 YEARS OF LOSS, 1928-1937)
OREGON AREAS – 7,400,000 ACRES
WASHINGTON AREAS – 3,600,000 ACRES
TOTAL 11,000,000 ACRES
PERCENT OF PINE VOLUME KILLED
PONDEROSA PINE ACREAGE AFFECTED
(ACRES IN MILLIONS)
AVERAGE FOR OREGON AREAS – 11.2 %
AVERAGE FOR WASHINGTON AREAS – 8.7 %
SNOW MTN. 270,000 ACRES
SPRAGUE RIVER 280,000 ACRES
BLY 150,000 A. PANHANDLE 13,000 ACRES
SILVER LAKE 145,000 ACRES
FOSSIL 255,000 A. MAURY MTN. 55,000 ACRES
OCHOCO CREEK 120,000 ACRES BONANZA 83,000 ACRES
GOLDENDALE 134,000 ACRES
PRINEVILLE 147,000 ACRES
SPOKANE INDIAN RES. 115,000 ACRES
WATERMAN 158,000 ACRES
ENTIAT 114,000 ACRES
CHEWAUCAN 195,000 ACRES LAKE CHELAN 83,000 ACRES
METHOW 320,000 ACRES
CABIN LAKE 230,000 ACRES
DOG LAKE 140,000 ACRES
KLAMATH 370,000 ACRES
KLICKITAT RIVER 200,000 ACRES
SYCAN 270,000 ACRES
DUFUR 170,000 ACRES
KENO 215,000 A. SINLAHEKIN 75,000 ACRES
COLVILLE NATL. FOREST 300,000 ACRES
GLENWOOD 145,000 ACRES
WARM SPRING 245,000 ACRES
BIG SUMMIT 175,000 ACRES
JOHN DAY 550,000 ACRES
IMNAHA 115,000 ACRES
SISTERS 330,000 ACRES
COLVILLE INDIAN RES. 700,000 ACRES
MALHEUR RIVER 310,000 ACRES
PENDLETON 150,000 ACRES
SILVIES 290,000 ACRES
SUMPTER 240,000 ACRES
TOPPENISH 165,000 ACRES
WEST PAULINA 120,000 ACRES
DALE 320,000 ACRES
BEAVER 100,000 ACRES
CRESCENT 215,000 ACRES
GRAND RONDE 460,000 ACRES
POMEROY 95,000 ACRES
WENATCHEE 230,000 ACRES
ELLENSBURG 200,000 A.
FT. KLAMATH 40,000 A.
LA GRANDE 150,000 ACRES
NACHES 230,000 ACRES
POWDER RIVER 100,000 A.
WARNER MTN. 100,000 A.
SPOKANE 560,000 ACRES

CHART 6

AVERAGE ANNUAL VALUE OF PONDEROSA PINE KILLED BY BEETLES
IN
OREGON AND WASHINGTON
AND
AMOUNT SPENT FOR CONTROL AND RESEARCH
DURING PERIOD OF 1931 - 1938



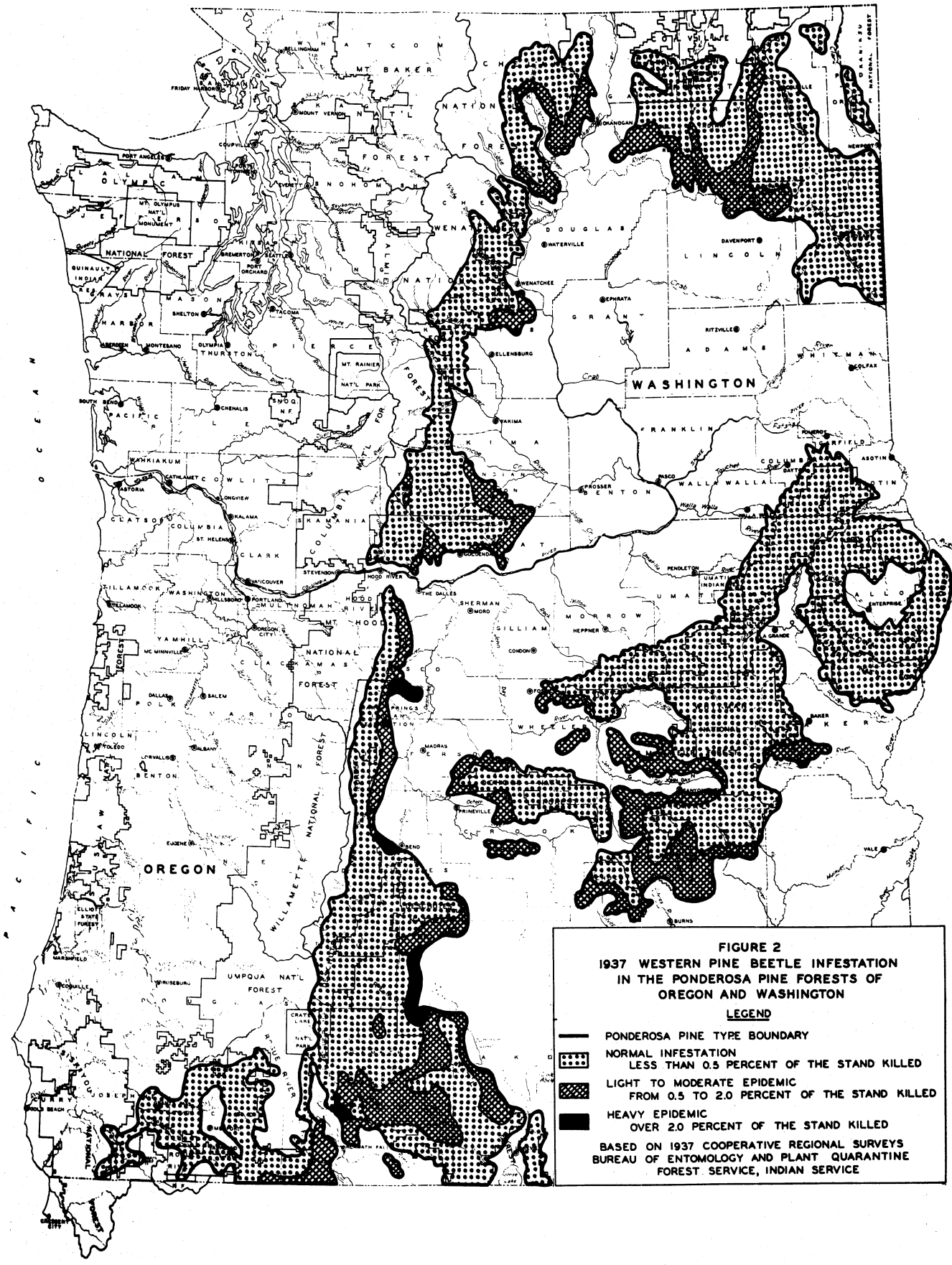


FIGURE 2
1937 WESTERN PINE BEETLE INFESTATION IN THE PONDEROSA PINE FORESTS OF OREGON AND WASHINGTON

LEGEND

- PONDEROSA PINE TYPE BOUNDARY
- NORMAL INFESTATION — LESS THAN 0.5 PERCENT OF THE STAND KILLED
- LIGHT TO MODERATE EPIDEMIC — FROM 0.5 TO 2.0 PERCENT OF THE STAND KILLED
- HEAVY EPIDEMIC — OVER 2.0 PERCENT OF THE STAND KILLED

BASED ON 1937 COOPERATIVE REGIONAL SURVEYS
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
FOREST SERVICE, INDIAN SERVICE

EXPLANATION OF FIGURES

Figure 1. This map of the Region shows the distribution of normal, light, and heavy infestation of the western pine beetle in 1932, at the peak of epidemic conditions.

Figure 2. This map, using the same legend as figure 1, shows the distribution of normal, light, and heavy infestation of the western pine beetle in 1937 at the low point of the recent infestation cycle.

The comparison between figure 1 and figure 2 shows the striking change in infestation conditions which has occurred between 1932 and 1937.

Figure 3

Major Projects 1938-1939
Forest Insect Laboratory
Portland, Oregon

1.* HEADQUARTERS LABORATORY, PORTLAND, OREGON.
Administration and supervision.
Central headquarters for all research projects.
General service work and dissemination of information on control of insects affecting forest and shade trees, and forest products.

DOUGLAS FIR REGION

FOREST INSECT COOPERATIVE SURVEYS AND CONTROL

2. Annual examination of fire-killed Douglas fir in the Tillamook burn of 1933 to determine the rate of deterioration.
3. Annual inspection of forest insect conditions in Mt. Rainier National Park.

FOREST INSECT RESEARCH

4. Control of the Douglas fir bark beetle in selectively cut areas.
5. Biological studies of ambrosia beetles.
6. Carpenter ant control experiments and rearing at field laboratory located at Lathrop Pack Demonstration Forest.

PONDEROSA PINE REGION

FOREST INSECT COOPERATIVE SURVEYS AND CONTROL

7. Supervision of annual regional western pine beetle surveys of federal, state, and privately-owned lands. The portions of the Region covered in 1938 are shown on the accompanying map, and the areas surveyed by BEPQ crews are designated by (7).
8. Annual inspection of forest insect conditions in Crater Lake National Park.

FOREST INSECT RESEARCH

9. Direct natural control of western pine beetle populations through low winter temperatures.
10. Determination of the factors of tree and area hazard contributing to western pine beetle infestations.
11. The influence of selective logging on subsequent insect damage.
12. Study of climatic relationships with tree rings.

*Numbers refer to project locations shown on accompanying map.

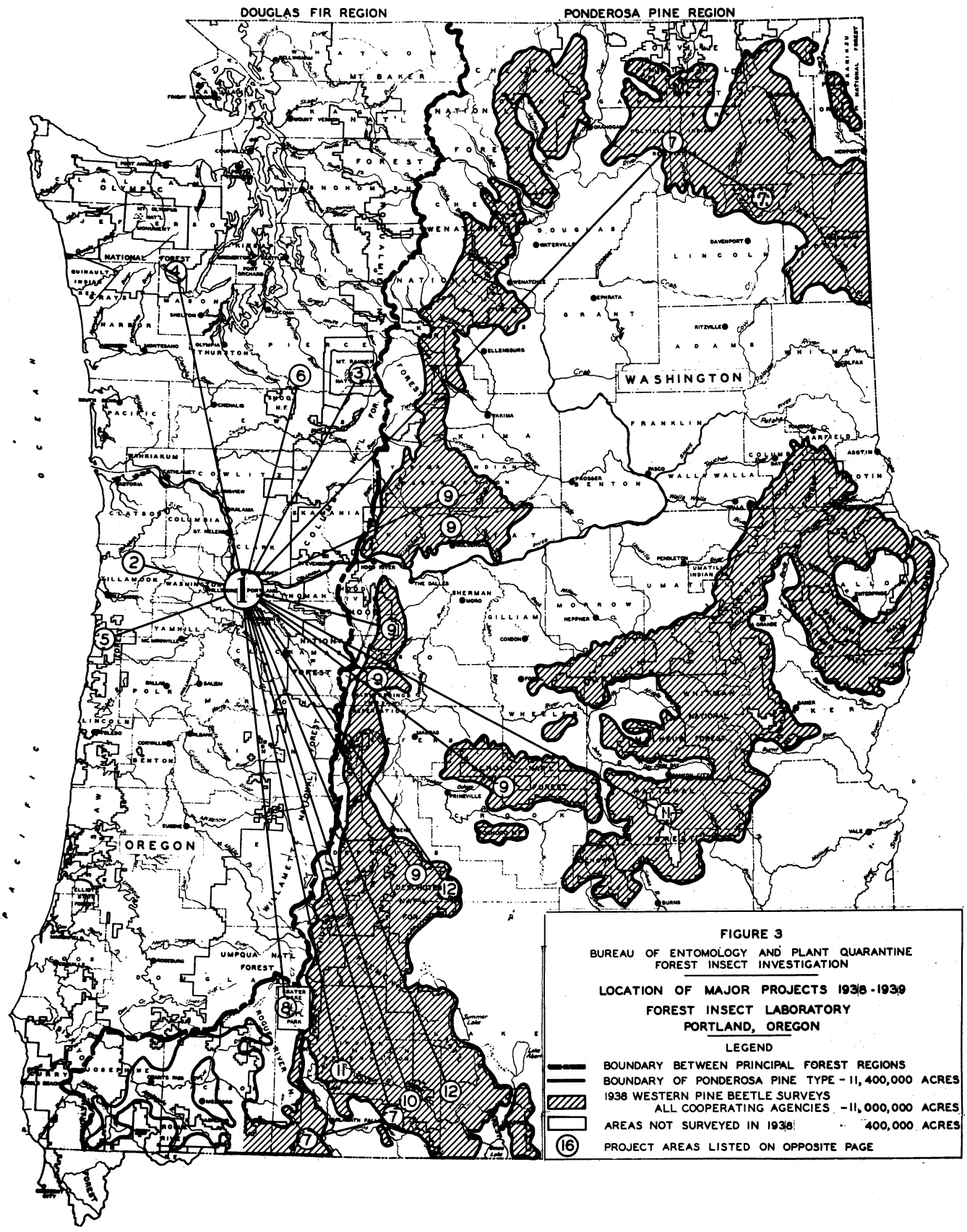

DOUGLAS FIR REGION
PONDEROSA PINE REGION
WASHINGTON
OREGON
PACIFIC OCEAN
FIGURE 3
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
FOREST INSECT INVESTIGATION
LOCATION OF MAJOR PROJECTS 1938-1939
FOREST INSECT LABORATORY
PORTLAND, OREGON
LEGEND
BOUNDARY BETWEEN PRINCIPAL FOREST REGIONS
BOUNDARY OF PONDEROSA PINE TYPE - 11,400,000 ACRES
1938 WESTERN PINE BEETLE SURVEYS
ALL COOPERATING AGENCIES - 11,000,000 ACRES
AREAS NOT SURVEYED IN 1938 - 400,000 ACRES
(16) PROJECT AREAS LISTED ON OPPOSITE PAGE

TABLE I

SUMMARY OF ACTUAL CRUISING DATA
SURVEY OF 1934

Administrative Areas	No. of Check Plots	Timbered Acres Cruised	Volume of Pine on Plots M.b.m.	Total Losses for 1933 Trees	Volume Bd. ft.	Gross: % of Stand	Bd.ft. per Acre
OREGON							
NATIONAL FORESTS							
Deschutes (2)	14	3,950	52,061	389	333,135	.64	84
Fremont (2)	5	1,525	17,904	203	147,610	.82	96
Malheur (2)	4	640	9,257	204	128,785	1.39	201
Ochoco (2)	17	5,555	61,880	2,494	1,743,630	2.82	314
Total	40	11,670	141,102	3,290	2,353,160	1.67	202
INDIAN RESERVATIONS							
Klamath (1)	3	1,780	16,674	453	316,835	1.90	178
Warm Springs (4)	17	10,487	112,797	3,636	2,120,600	1.88	202
Total	20	12,267	129,471	4,089	2,437,435	1.88	199
PRIVATE							
Klamath Forest Prot. Assn. (1)	16	9,550	121,193	2,250	1,794,265	1.48	188
OREGON TOTAL	76	33,487	391,766	9,629	6,584,860	1.68	196
WASHINGTON							
INDIAN RESERVATIONS							
Colville-Spokane (3)	2	640	5,379	81	41,110	.77	64
Yakima (4)	16	8,960	84,769	3,303	2,808,000	3.32	313
Total	18	9,600	90,148	3,384	2,849,110	3.16	297
WASHINGTON TOTAL	18	9,600	90,148	3,384	2,849,110	3.16	297
TOTAL FOR REGION	94	43,087	481,914	13,013	9,433,970	1.96	218

(1) Surveyed by Bureau of Entomology and Plant Quarantine.
(2) " cooperatively by BEPQ and Forest Service.
(3) " " by BEPQ and Indian Service.
(4) " by Indian Service.

Table 2

SUMMARY OF ACTUAL CRUISING DATA
SURVEY OF 1935

Administrative Areas	No. of Check Plots	Timbered Acres Cruised	Volume of Pine on Plots M.b.m.	Total Losses for 1934 Trees	Volume Bd. ft.	Gross % of Stand	Bd.ft. per Acre
OREGON							
NATIONAL FORESTS							
Deschutes (2)*	12	3,630	44,786	669	489,320	1.09	135
Fremont (2)	5	1,525	16,709	325	249,770	1.49	164
Malheur (2)	4	640	9,128	77	37,980	.42	59
Ochoco (2)	14	4,675	46,857	1,537	1,005,065	2.12	212
Total	35	10,470	117,480	2,608	1,782,135	1.52	171
INDIAN RESERVATIONS							
Klamath (1)	3	1,780	16,357	513	420,395	2.58	236
Warm Springs (4)	17	10,487	110,677	4,557	2,904,400	2.62	278
Total	20	12,267	127,034	5,070	3,324,795	2.61	271
PRIVATE							
Klamath Forest Prot. Assn. (1)	15	8,920	114,202	2,792	2,186,020	1.91	245
OREGON TOTAL	70	31,657	358,716	10,470	7,292,950	2.03	230
WASHINGTON							
NATIONAL FORESTS							
Chelan (2)	2	640	5,725	28	12,060	.21	19
Colville (2)	1	320	2,292	21	8,040	.35	25
Snoqualmie (2)	1	305	4,746	27	24,820	.53	81
Wenatchee (2)	2	640	5,061	28	8,180	.16	13
Total	6	1,905	17,824	104	43,100	.24	23
INDIAN RESERVATIONS							
Colville-Spokane (3)	2	640	6,606	28	23,480	.35	37
Yakima (4)	19	9,760	81,961	2,138	1,154,000	1.41	118
Total	21	10,400	88,567	2,166	1,177,480	1.32	113
WASHINGTON TOTAL	27	12,305	106,391	2,270	1,220,580	1.15	99
TOTAL FOR REGION	97	43,962	465,107	12,740	8,513,530	1.85	196

* Numbers refer to agency conducting survey as shown at bottom of Table 1, page 37.

Table 3

SUMMARY OF ACTUAL CRUISING DATA
SURVEY OF 1936

Administrative Areas		No. of Check Plots	Timbered Acres Cruised	Volume of Pine on Plots M.b.m.	Total Losses for 1935 Trees	Volume Bd.ft.	Gross % of Stand	Bd.ft. per Acre
				OREGON				
NATIONAL FORESTS								
Deschutes	(2)*	17	5,240	68,478	1,551	903,650	1.32	172
Fremont	(2)	15	4,585	52,083	838	512,700	.98	112
Malheur	(2)	9	2,893	34,873	264	240,520	.69	83
Ochoco	(2)	24	7,685	81,411	1,069	705,920	.87	92
Umatilla	(2)	3	950	7,348	134	101,550	1.38	107
Whitman	(2)	3	960	9,421	62	47,800	.51	50
Total		71	22,313	253,614	3,918	2,512,140	.99	113
INDIAN RESERVATIONS								
Klamath	(1)	3	1,780	15,937	437	308,890	1.94	173
Warm Springs	(4)	17	10,487	107,782	2,781	1,656,500	1.54	158
Total		20	12,267	123,719	3,218	1,965,390	1.59	160
PRIVATE								
Klamath Forest Prot. Assn.	(1)	13	7,760	105,363	1,840	1,289,860	1.22	166
OREGON TOTAL		104	42,340	482,696	8,976	5,767,390	1.20	136
				WASHINGTON				
NATIONAL FORESTS								
Chelan	(2)	2	640	5,713	65	35,740	.63	56
Colville	(2)	1	320	2,283	18	7,550	.33	24
Snoqualmie	(2)	1	305	4,675	9	7,270	.16	24
Wenatchee	(2)	2	640	5,053	53	15,630	.31	25
Total		6	1,905	17,724	145	66,190	.37	35
INDIAN RESERVATIONS								
Colville-Spokane	(3)	4	1,160	7,727	50	23,740	.31	20
Yakima	(4)	19	9,760	88,127	526	329,000	.37	34
Total		23	10,920	95,854	576	352,740	.37	32
PRIVATE								
Klickitat County	(1)	4	1,270	11,066	48	23,610	.21	18
WASHINGTON TOTAL		33	14,095	124,644	769	442,540	.36	31
TOTAL FOR REGION		137	56,435	607,340	9,745	6,209,930	1.03	110

*Numbers refer to agency conducting survey, as shown at bottom of table 1, page 37.

Table 4

SUMMARY OF ACTUAL CRUISING DATA
SURVEY OF 1937

Administrative Areas		No. Check Plots	Timbered Acres Cruised	Volume of Pine on Plots M.b.m.	Total Losses for 1936 Trees	Volume Bd. ft.	Gross % of Stand	Gross Bd.ft. per Acre
OREGON								
NATIONAL FORESTS								
Deschutes	(2)*	16	4,920	61,988	922	527,860	.85	107
Fremont	(2)	15	4,585	51,562	756	560,300	1.09	122
Malheur	(2)	10	3,193	44,938	390	246,060	.55	77
Ochoco	(2)	19	6,205	62,565	880	600,110	1.23	96
Umatilla	(2)	3	950	7,246	149	115,350	1.59	186
Whitman	(2)	3	960	9,372	74	45,770	.49	48
Total		66	20,813	237,671	3,171	2,095,450	.89	100
INDIAN RESERVATIONS								
Klamath	(1)	3	1,780	15,587	312	205,910	1.32	115
Warm Springs	(4)	17	10,487	106,010	2,028	1,349,400	1.27	129
Total		20	12,267	121,597	2,340	1,555,310	1.28	127
PRIVATE								
Klamath Forest Prot. Assn.	(1)	13	7,760	103,081	908	668,910	.65	86
OREGON TOTAL		99	40,840	462,349	6,419	4,319,670	.94	106
WASHINGTON								
NATIONAL FORESTS								
Chelan	(2)	2	640	5,677	43	33,200	.59	52
Colville	(2)	1	320	2,276	20	14,400	.63	45
Snoqualmie	(2)	1	305	4,670	5	3,970	.08	13
Wenatchee	(2)	2	640	5,037	24	7,590	.15	12
Total		6	1,905	17,660	92	59,160	.34	31
INDIAN RESERVATIONS								
Colville-Spokane	(3)	4	1,160	7,683	109	46,580	.61	40
Yakima	(4)	19	9,760	87,798	408	261,000	.30	27
Total		23	10,920	95,481	517	307,580	.32	28
PRIVATE								
Klickitat County	(1)	4	1,270	11,043	74	45,150	.41	36
WASHINGTON TOTAL		33	14,095	124,184	683	411,890	.33	29
TOTAL FOR REGION		132	54,935	586,533	7,102	4,731,560	.81	86

* Numbers refer to agency conducting survey, as shown at bottom of Table 1, page 37.

Table 5

SUMMARY OF ACTUAL CRUISING DATA
SURVEY OF 1938

Administrative Areas	No. of Check Plots	Timbered Acres Cruised	Volume of Pine on Plots M.b.m.	Total Losses for 1937 Trees	Volume Bd. ft.	Gross % of Stand	Bd.ft. per Acre
NATIONAL FORESTS			**OREGON**				
Deschutes (2)**	27	8,560	118,410	819	545,710	.46	64
Fremont (2)	17	5,115	65,038	566	460,525	.71	90
Malheur (2)	16	5,018	76,761	557	426,840	.56	85
Mt. Hood (2)	3	940	8,268	176	103,920	1.25	111
Ochoco (2)	28	8,989	96,657	1,172	898,425	.93	100
Rogue River (1)	4	1,280	24,440	57	70,550	.29	55
Umatilla (2)	12	3,422	30,702	431	239,575	.77	70
Wallowa (2)	3	790	9,379	51	44,940	.48	57
Whitman (2)	10	3,197	30,036	326	239,790	.80	75
Total	120	37,311	459,691	4,155	3,030,275	.66	81
INDIAN RESERVATIONS							
Klamath (1,4)	5	2,420	23,230	336	261,910	1.12	108
Klamath (4)	13	8,000	76,800*	438	337,000*	.44*	42*
Warm Springs (4)	14	8,576	85,627	1,751	1,050,600*	1.23*	123*
Total	32	18,996	185,657	2,525	1,659,510	.89	87
PRIVATE							
Klamath Forest Prot. Assn. (1)	13	7,690	114,407	841	719,100	.63	94
OREGON TOTAL	165	63,997	759,755	7,521	5,408,885	.71	85
NATIONAL FORESTS			**WASHINGTON**				
Chelan (2)	5	1,540	12,613	90	58,030	.46	38
Colville (2)	2	590	3,768	23	17,530	.47	30
Snoqualmie (2)	3	895	9,930	43	33,260	.33	37
Wenatchee (2)	5	1,600	11,379	49	22,980	.20	14
Total	15	4,625	37,690	205	131,800	.35	29
INDIAN RESERVATIONS							
Colville-Spokane (3)	7	2,240	13,565	88	47,910	.35	21
Yakima (4)	8	5,120	41,923	323	206,700*	.50*	40*
Total	15	7,360	55,488	411	254,610	.46	35
PRIVATE							
Klickitat County (1)	5	1,580	13,184	67	35,745	.27	23
WASHINGTON TOTAL	35	13,565	106,362	683	422,155	.40	31
TOTAL FOR REGION	200	77,562	866,117	8,204	5,831,040	.67	75

* Estimated. ** Numbers refer to agency conducting survey, as shown at bottom of Table 1, page 37.

Table 6

GRAND SUMMARY OF CRUISING DATA
ON VIRGIN PONDEROSA PINE FORESTS
SURVEYS OF 1934-1938, INCLUSIVE

LOCATIONS OF PLOTS IN VIRGIN STANDS

Survey Year	Natl. Forests: No. Plots	Natl. Forests: Acreage Surveyed	Indian Reservations: No. of Plots	Indian Reservations: Acreage Surveyed	Private: No. of Plots	Private: Acreage Surveyed	Total: No. of Plots	Total: Acreage Surveyed
1934	40	11,670	38	21,867	16	9,550	94	43,087
1935	41	12,375	41	22,667	15	8,920	97	43,962
1936	77	24,198	43	23,187	17	9,030	137	56,415
1937	72	22,718	43	23,187	17	9,030	132	54,935
1938	135	41,936	47	26,356	18	9,270	200	77,562
Total	365	112,897	212	117,264	83	45,800	660	275,961

ANNUAL CRUISE MADE BY

Survey Year	Bur. of Ent. & Plant Quar.: No. of Plots	Bur. of Ent. & Plant Quar.: Acres Surveyed	BEPQ & For. Service: No. of Plots	BEPQ & For. Service: Acres Surveyed	BEPQ & Indian Service: No. of Plots	BEPQ & Indian Service: Acres Surveyed	Indian Service: No. of Plots	Indian Service: Acres Surveyed	Total: No. of Plots	Total: Acres Surv.
1934	19	11,330	40	11,670	2	640	33	19,447	94	43,087
1935	18	10,700	41	12,375	2	640	36	20,247	97	43,962
1936	20	10,810	77	24,198	4	1,160	36	20,247	137	56,415
1937	20	10,810	72	22,718	4	1,160	36	20,247	132	54,935
1938	23	11,100	131	40,656	7	2,240	39	23,566	200	77,562
Total	100	54,750	361	111,617	19	5,840	180	103,754	660	275,961

Table 7

ESTIMATED PINE BEETLE DAMAGE TO
MATURE AND OVERMATURE PONDEROSA PINE STANDS
OF OREGON AND WASHINGTON

Subregion, Division, and Area	Percent of Ponderosa Pine Stand Killed						
	1933	1934	1935	1936	1937	5-year total 1933-1937	10-year total 1928-1937
OREGON							
KLAMATH SUBREGION							
Klamath Lake Division							
Keno Area	.8	1.4	.7	.3	.3	3.5	11.0
Ft. Klamath Area	.5	.8	.4	.3	.2	2.2	5.0
Sprague River Division							
Bonanza Area	1.2	1.5	1.4	.6	.4	5.1	15.0
Bly Area	1.7	1.4	.9	.6	.6	5.2	21.0
Sprague River Area	1.4	2.0	1.5	.9	.7	6.5	22.0
Marsh Division							
Beaver Marsh	.6	.8	.6	.4	.3	2.7	7.0
Klamath Marsh	1.0	1.4	1.2	.5	.4	4.5	12.0
Sycan Marsh	1.2	1.4	1.3	.5	.4	4.8	12.0
Lakeview Division							
Dog Lake Area	.7	.6	.5	.8	.8	3.4	12.3
Chewaucan Area	.8	1.0	.8	1.0	1.5	5.1	13.0
Warner Mt. Area	.5	.8	.4	.3	.2	2.2	5.0
Silver Lake Area	1.5	2.7	2.0	1.8	1.5	9.5	18.0
Summer Lake Area	1.0	1.2	1.0	1.2	1.0	5.4	12.0
DESCHUTES SUBREGION							
Lower Deschutes Division							
Dufur Area	1.6	1.9	1.2	1.0	.8	6.5	11.0
Warm Springs Area	1.6	2.2	1.3	1.0	.8	6.9	10.0
Sisters Area	.9	.6	1.0	.8	.6	3.9	9.0
Upper Deschutes Division							
Crescent Area	.5	.7	.5	.7	.4	2.8	6.0
West Paulina Area	.6	.8	.7	.6	.4	3.1	7.0
Cabin Lake Area	1.0	2.0	2.6	1.4	.5	7.5	12.3
Panhandle Area	2.8	1.9	1.2	1.0	1.1	8.0	18.0

(continued on next page)

Table 7
(continued)

Subregion, Division, and Area	Percent of Ponderosa Pine Stand Killed						
	1933	1934	1935	1936	1937	5-year total 1933-1937	10-year total 1928-1937
BLUE MOUNTAIN SUBREGION				**OREGON (continued)**			
Ochoco Division							
Prineville Area	2.8	1.9	1.5	.6	.7	7.5	15.0
Ochoco Creek Area	2.0	2.1	1.0	.8	.6	6.5	16.0
Maury Mt. Area	3.1	1.5	.7	.6	.8	6.7	16.0
Summit Prairie Area	1.2	.6	.5	.8	.5	3.6	10.0
John Day Division							
Fossil Area	2.4	.8	.6	1.2	1.3	6.3	16.0
Dale Area	.7	.9	.3	.2	.4	2.5	7.0
Mitchell Area	2.0	.8	.4	.7	.6	4.5	14.0
John Day Area	.7	1.3	1.0	1.0	.5	4.5	9.0
Burns Division							
Snow Mt. Area	2.3	.8	1.0	1.4	1.2	6.7	24.0
Silvies Area	1.0	.3	.6	.5	.7	3.1	8.0
Malheur River Area	1.0	.3	.7	.5	.5	3.0	8.0
Baker Division							
Sumpter Area	.5	1.5	1.0	.6	.8	4.4	8.0
Powder River Area	.3	.9	.6	.4	.5	2.7	5.0
La Grande Division							
Pendleton Area	.5	1.5	1.0	.6	.3	3.9	8.0
La Grande Area	.3	.9	.6	.4	.5	2.7	5.0
Grande Ronde Area	.5	1.0	.7	.5	.6	3.3	6.0
Imnaha Area	.7	1.4	1.0	.7	.3	4.1	9.0
Pomeroy Area (Wash.)	.5	1.0	.7	.5	.2	2.9	6.0
EASTERN WASHINGTON				**WASHINGTON**			
Chelan Division							
Methow Area	1.7	.4	1.2	1.0	.9	5.2	12.5
Sinlahekin Area	1.6	.5	.9	.8	.5	4.3	11.0
Colville Division							
Colville Ind. Res.	.8	.7	.4	.8	.7	3.4	8.0
Colville Natl. For.	1.0	.5	.4	.6	.5	3.0	10.0
Spokane Division							
Spokane Area	.6	.5	.3	.3	.4	2.1	5.0
Spokane Ind. Res.	1.6	.9	.5	.8	.9	4.7	14.0
Wenatchee Division							
Entiat Area	1.5	.5	.6	.5	.4	3.5	13.0
Lake Chelan Area	1.7	.5	1.2	1.0	.8	5.2	13.0
Wenatchee Area	1.0	.2	.3	.2	.3	2.0	6.0
Yakima Division							
Ellensburg Area	.8	.4	.3	.2	.3	2.0	5.0
Naches Area	1.3	.6	.2	.1	.6	2.8	5.0
Toppenish Area	1.2	.5	.1	.1	.5	2.4	8.0
Klickitat Division							
Goldendale Area	3.0	1.0	.2	.5	.3	5.0	15.0
Klickitat River Area	2.0	1.8	.3	.4	.3	4.8	12.0

Table 8

TOTAL EASTSIDE PONDEROSA PINE LOSSES
FROM BEETLE ATTACK, 1921-1937

Period	Losses in Millions of Bd. ft. Oregon	Washington	Total
1921-1930, incl.	6,900	1,350	8,250
1931	910	130	1,040
1932	1,440	270	1,710
1933	640	210	850 ? {606 1933 report}
1934	660	120	780
1935	520	60	580
1936	400	60	460
1937	320	60	380
Total, 1931-1937	4,890	910	5,800
Av., 1921-1930	690	135	825
Yrly. Av., 1931-1937	698	130	828
Yrly. Av., 1921-1937	694	133	826

Table 9

CONTROL WORK CONDUCTED DURING PERIOD
FALL 1933 TO SPRING 1934

Western Pine Beetle Control in Ponderosa Pine

Cost/Tree	Forest and Project	Trees Treated	Volume Treated M.b.m.	Acres Covered	Cost	Work Done by
	Deschutes National Forest					
2.37	Panhandle-Orphan Butte	3,055	2,500	16,660	$ 7,240	Forest Service Fall 1933 (NIRA)
	Ochoco National Forest					
1.94	Prineville Project	4,726	4,503	14,920	9,175	KFPA *
3.10	Mill Creek	4,798	4,150	30,080	14,874	Forest Service Fall 1933 (NIRA)
3.17	Maury Mountain	7,976	5,921	58,600	25,284	Forest Service Fall 1933 (NIRA)
	Klamath County					
2.16	Bly District	1,145	1,625	4,440	2,472	KFPA
1.24	Yawkey Tract	62	104	5,120	77	KFPA
9.26	Yakima Indian Reservation	2,871	4,733	7,840	26,585	Indian Service (ECW)
4.22	Warm Springs Indian Reservation	1,785	1,036	17,680	7,540	Indian Service (ECW)

Mountain Pine Beetle Control in Lodgepole and White Pine

	Rogue River National Forest					
0.85	Sun Pass	6,208	-	10,040	$ 5,276	Forest Service Spring 1934 (ECW)
0.98	Crater Lake National Park	1,020	-	-	1,000	Natl. Park Service (ECW)
3.52	Mt. Rainier National Park	122	-	-	430	Natl. Park Service (ECW)

* Klamath Forest Protective Association.

Table 10

CONTROL WORK CONDUCTED DURING PERIOD
FALL 1934 TO SPRING 1935

Forest and Project	Trees Treated	Volume Treated M.b.m.	Acres Covered	Cost	Work Done by
Cost/Tree	**Western Pine Beetle Control in Ponderosa Pine**				
Deschutes National Forest					
3.78 Metolius Area	3,600	-	74,280	$13,608	Forest Service (ECW)
2.75 Summit Stage Station	506	-	7,480	2.75 per tree.	Shevlin-Hixon
2.75 Pot Holes	1,795	-	16,360	" "	" " "
3.96 Flat Top	1,652	-	17,520	6,540	Forest Service (NIRA)
Ochoco National Forest					
4.50 Maury Mt.	4,015	3,000*	58,600	18,067	Forest Service (NIRA)
5.61 Mill Creek	1,337	-	30,080	7,501	" " "
3.26 Marks Ochoco	3,552	-	30,100	11,366	" " (ECW)
2.58 Prineville	1,528	1,490	6,200	3,947	KFPA **
Indian Reservations					
8.41 Klamath	3,328	2,283	41,290	27,973	Indian Service (ECW)
3.58 Warm Springs	17,394	11,337	74,376	62,316	" " "
9.10 Yakima	4,889	3,142	46,800	44,483	" " "
Klamath County					
2.02 Keno District	1,051	1,055	4,880	2,124	KFPA, spring 1935
2.02 Bly District	2,913	3,569	15,160	5,888	" " "
	Mountain Pine Beetle Control in Lodgepole and White Pine				
Rogue River National Forest					
1.72 Sun Pass	1,440	-	6,200	2,483	Forest Service Spring 1935 (ECW)
Mt. Rainier National Park 9.64	61	-	-	588	National Park Service (ECW)

* Estimated.

** Klamath Forest Protective Association.

Table 11

CONTROL WORK CONDUCTED DURING PERIOD
FALL 1935 TO SPRING 1936

Western Pine Beetle Control in Ponderosa Pine

Forest and Project	Trees Treated	Volume Treated M.b.m.	Acres Covered	Cost	Work Done by
Cost/tree					
Deschutes National Forest					
4.37 Sisters Project	418	-	9,400	$ 1,827	Forest Service (CCC)
0.60 China Hat	875	-	5,800	525	Brooks-Scanlon Salvage
0.44 Fox Butte	600	-	2,550	264	Brooks-Scanlon Salvage
Fremont National Forest					
4.72 Bly Project	519	-	9,880	2,451	Forest Service (CCC)
Ochoco National Forest					
3.34 Marks-Ochoco	1,536	-	40,080	5,125	Forest Serv. (CCC)
2.95 Prineville	397	268	2,720	1,171	KFPA,* Fall 1935
Klamath Forest Protective Association					
2.25 Bly District	1,303	1,703	9,200	2,932	KFPA, Fall 1935
2.14 Aspen Lake	3,926	4,421	11,720	8,410	" , Spring 1936
Indian Reservations					
★ 27.14 Yakima	1,144	1,638	27,160	31,049	Indian Service (ECW)
6.13 Warm Springs	11,904	7,867	84,340	72,952	" " "
9.60 Klamath	1,787	536**	11,000**	17,163	" " "

* Klamath Forest Protective Association.
** Estimated.

WPB
Ave Total Cost/Tree
5.26

Table 12

CONTROL WORK CONDUCTED DURING PERIOD
FALL 1936 TO SPRING 1937

Western Pine Beetle Control in Ponderosa Pine

Forest and Project	Trees Treated	Volume Treated M.b.m.	Acres Covered	Cost	Work Done by
Deschutes National Forest					
Sixteen Butte	4,076	-	36,790	$13,540	Forest Service (ERA)
Pine Mountain	573	-	5,440	1,862	" " "
Klamath County					
Keno Area	231	296	2,640	967	Klamath Forest
Bly District	606	848	5,680	2,635	Protective Assn.
Indian Reservations					
Warm Springs	4,743	3,146*	36,726	27,208	Indian Service (ECW)
Klamath	2,500*	750*	30,000*	11,154	" " "
Ochoco National Forest					
Prineville Project	86	90	640	425	KFPA **

Table 13

CONTROL WORK CONDUCTED DURING PERIOD
FALL 1937 TO SPRING 1938

Western Pine Beetle Control in Ponderosa Pine

Forest and Project	Trees Treated	Volume Treated M.b.m.	Acres Covered	Cost	Work Done by
Indian Reservations					
Warm Springs	4,232	2,565*	26,270	$27,162	Indian Service (CCC-ID)
Yakima	354	350*	8,080	6,880	" " "
Klamath	4,070	2,271*	31,190	43,263	" " "
Klamath County					
Keno Area	1,007	1,407	13,680	4,723	KFPA

* Estimated.

** Klamath Forest Protective Association.

Table 14

TOTAL EXPENDITURES FOR FOREST INSECT CONTROL
AND RESEARCH DURING FISCAL YEARS
1931-1938, INCLUSIVE

Western Pine Beetle Control	Total Expenditures	
Indian Service	$ 460,703	
Forest Service	160,261	
Private timber owners	118,339	$739,303
Mountain Pine Beetle Control		
National Park Service	$ 48,665	
Forest Service	9,756	58,421
Hemlock Looper Control (Airplane Dusting)		
Private timber owners	$ 7,310	
State of Washington	6,810	
Pacific County	500	14,620
Forest Insect Research		
Bureau of Entomology and Plant Quarantine.....		101,888
Total		$914,232

REFERENCE LIST OF DETAILED REPORTS, MEMORANDA, AND PUBLICATIONS RELATING TO FOREST INSECT PROBLEMS IN THE PACIFIC NORTHWEST 1934-1939*

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Beal, J. A., Kimmey, J. W., Rapraeger, F. F.

(2) "Deterioration of fire-killed Douglas fir"--The Timberman. Vol. 37, No. 2, pp. 13-17. December 1935.

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(3) "An improved cyanide killing jar."--ET Series, No. 57, May 1935.

(4) "A cage for rearing bark- and wood-boring insects under field conditions."--ET Series, No. 79. April 1936.

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(5) "Bark beetles active following Tillamook fire"--The Timberman Vol. 37, No. 3, pp. 21-22. January 1936.

(6) "Salvage on Tillamook burn as affected by insect activity"--The Timberman, Vol. 39, No. 2, pp. 11-13, 30, 32, illus. December 1937.

(7) "Insects attacking forest products and shade trees in Washington and Oregon in 1937"--Proceedings of the Entomological Society of British Columbia. No. 35, pp. 5-8. February 25, 1939.

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(9) "Climatic cycles in Eastern Oregon as indicated by tree rings"--Monthly Weather Review, Vol. 65, No. 5, pp. 175-188, illus, May 1937.

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* A list of publications in the files of the Portland Forest Insect Laboratory since the report of May 1, 1934 (16).

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FOREST INSECT RESEARCH REPORTS

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(12) "Miscellaneous examinations and observations made by members of the Portland Forest Insect Laboratory during the year 1936." --1936.

(13) "Report of general service work and extension for calendar year 1937"--January 20, 1938.

(14) "Memorandum of the establishment of an insectary at Pack Forest, La Grande, Wash., and program for 1938"--March 18, 1938.

(15) "Memorandum on drought injury to reproduction in the Rogue River Valley during the fall of 1936."--September 1938.

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(16) "Annual report of the forest insect conditions in Oregon and Washington for 1933"--May 1, 1934.

(17) "Report for 1935 and investigative program for 1937."--March 10, 1936.

(18) "A brief illustrated sketch of the problems and activities of the Forest Insect Laboratory at Portland, Oregon"--July 25,1936.

(19) "Annual progress report for calendar year 1937 and program of work for 1938"--January 15, 1938.

(20) "Annual progress report for calendar year 1938"--January 1939.

(21) "Program of work for 1939"--January 1939.

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(22) "A joint statement of present conceptions of ponderosa pine susceptibility to forest insect attack."--Manuscript. November 1938.

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(23) "Instructions for 1938 western pine beetle regional surveys, Oregon and Washington"--July 1938.

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(25) "Additional observations on the effects of low temperature upon overwintering populations of Dendroctonus brevicomis, Oregon"--February 19, 1936.

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(29) "Deterioration and usability of fire-killed Douglas fir." Manuscript. May 1935.

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FOREST INSECT RESEARCH REPORTS

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(33) "Report of carpenter ant control investigations at Pack Forest, La Grande, Wash."--February 1, 1938.

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(35) "Memorandum of inspection of the pine beetle situation on Indian Reservations of the Pacific Northwest August 22 to September 5, 1935"--September 10, 1935.

Weaver, Harold

(36) "I.E.C.W. pine beetle control in the Pacific Northwest"--December 6, 1934.

(37) "Pine beetle control activities on Indian Reservations of the Pacific Northwest, October 1934 to May 1935"--July 1, 1935.

(38) "The pine beetle situation on the Indian Reservations of the Pacific Northwest, 1937"--April 18, 1938.

(39) "The pine beetle situation on Indian Reservations of the Pacific Northwest, 1938"--March 1939.

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(40) "Memorandum of bark-beetle survey on Colville Indian Reservation, Fall of 1935"--March 1, 1936.

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(41) "Memorandum on pine beetle situation, Spokane Indian Reservation, Wash." -- July 5, 1934.

(42) "E.C.W. memorandum on pine beetle situation, Colville Indian Reservation, Wash." -- July 5, 1934.

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(51) "The pine bark-beetle infestation on the Warm Springs Indian Reservation, Oregon, 1936"--Emergency Conservation Report. February 8, 1937.

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(60) "The status of the pine bark beetle infestation on the Yakima Indian Reservation, 1936"—November 6, 1936.

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(61) "Bark-beetle survey on Chelan National Forest, fall of 1935" March 1, 1936.

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(62) "Report of pine beetle surveys on the Chelan National Forest of Washington, 1931-1938"—December 1938.

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(78) "Memorandum on insect losses on the holdings of the Ochoco Timber Company"--May 23, 1935.

(79) "Memorandum for Supervisor on the E.C.W. Ochoco Creek-Marks Creek Insect Control Project"--November 6, 1935.

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(80) "Report on the bark-beetle plots on the Ochoco National Forest" December 14, 1934.

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(99) "Report of pine beetle surveys on the Bonanza and Bly Areas, Klamath Basin, Oregon"--October 1938.

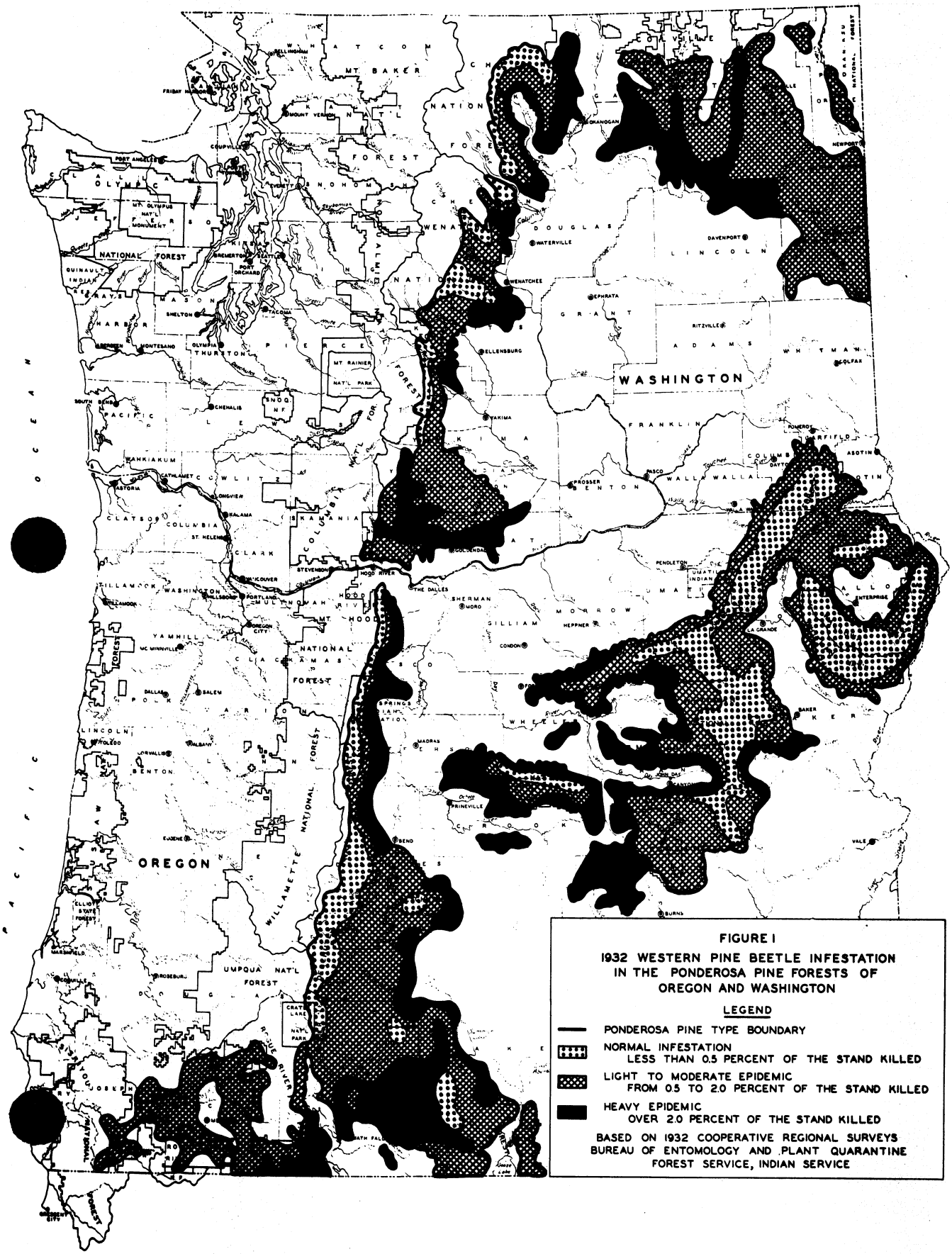

FIGURE I

1932 WESTERN PINE BEETLE INFESTATION IN THE PONDEROSA PINE FORESTS OF OREGON AND WASHINGTON

LEGEND

- PONDEROSA PINE TYPE BOUNDARY
- NORMAL INFESTATION — LESS THAN 0.5 PERCENT OF THE STAND KILLED
- LIGHT TO MODERATE EPIDEMIC — FROM 0.5 TO 2.0 PERCENT OF THE STAND KILLED
- HEAVY EPIDEMIC — OVER 2.0 PERCENT OF THE STAND KILLED

BASED ON 1932 COOPERATIVE REGIONAL SURVEYS
BUREAU OF ENTOMOLOGY AND PLANT QUARANTINE
FOREST SERVICE, INDIAN SERVICE